VOLUME 60 [W. B. No. 1068] NUMBER 1

MONTHLY WEATHER REVIEW

JANUARY, 1932

CONTENTS

UNITED STATES DEPARTMENT OF AGRICULTURE
WEATHER BUREAU
WASHINGTON, D. C.

For sale by the Superintendent of Documents, Washington, D. C. - - - - - - - - - - - - - See page 4 of cover for prices

MONTHLY WEATHER REVIEW

Editor, W. J. HUMPHREYS

Vol. 60, No. 1
W. B. No. 1068

JANUARY, 1932

Closed March 3, 1932
Issued April 7, 1932

METEOROLOGICAL CONDITIONS AFFECTING THE FREEMAN LAKE (IDAHO) FIRE

By George M. Jemison, *Junior Forester*

[Northern Rocky Mountain Forest and Range Experiment Station]

Measurements of meteorological conditions prevailing during the rapid spread of forest fires are greatly needed so that when their recurrence seems probable, fire-weather forecasters may issue warnings of the danger. Such determinations also can be used by forest protective agencies which operate meteorological stations to guide their own action in the distribution of men and the hiring of fire fighters whenever their instruments reveal the early probability or actual existence of these dangerous conditions.

The results of one study of this kind were published in 1927 by Gisborne,[1] who found that during the seven worst days of the Quartz Creek fire in northern Idaho the average maximum temperature ranged between 72° and 88° F.; the minimum relative humidity, between 13 and 24 per cent; while the average afternoon wind velocity varied from 9.8 to 15.0 miles per hour. The average afternoon moisture content of the duff during these seven bad days was 7 per cent and the average area burned 1,500 acres per day.

On August 3, 1931, another opportunity occurred for measuring weather and fuel-moisture conditions during a bad fire day when the Freeman Lake fire burned over 20,000 acres between 10:30 a. m. and 11:00 p. m., averaging 1,600 acres per hour for 12½ hours. Like the Quartz Creek fire, this more recent one came within 2 miles of the Priest River Forest Experiment Station. The weather records obtained at this station on these occasions therefore can be compared with references to the rate of fire spread.

Measurements made here include both meteorological and fuel-moisture conditions. At the primary meteorological station the conventional measurements of temperature, humidity, wind, and precipitation are amplified by the use of a hygrothermograph and a 2-magnet register with the anemometer installed in a tree top 150 feet high and 70 feet above the tops of surrounding trees. Three other stations also are operated especially to measure forest inflammability, one on an open area fully exposed to sun, wind, and rain; one on a half-cut-over area in the partial shelter of the remaining trees; and one under a complete timber canopy in an uncut stand where the forest exerts its maximum effect in maintaining fuels moist and in reducing the wind velocity. At each of these stations, measurements are made twice daily of the amount of moisture in the duff (dead leaves and twigs covering the forest floor) and in samples of slash varying in diameter from one-half to 2 inches. At each station, hygrothermographs record the air temperature and humidity, and soil thermometers register the temperature in the surface of the duff.

The Freeman Lake fire started at 10:30 a. m. near the base of a southwest slope, which is naturally an exceptionally dry exposure, and in a stand of young Douglas fir interspersed with patches of brush and grass. The latter are recognized as fuel types which produce exceptionally rapid spread of fire. Although discovered by the lookouts 20 minutes after it originated, and even though 11 men reached it and began work 1 hour and 10 minutes after origin, this fire spread from a spot to over 20 acres in that short time and was beyond control by the first crew. Additional reinforcements of 31 men reached the fire at 12:20 p. m. and 50 more arrived at 5:00 p. m. that day, but the spread continued and even accelerated its rate until about 11:00 p. m. that night. By midnight 640 men were working on the fire line, and the fire was under control 3 days later.

Table 1.—*Fuel and weather conditions at the Priest River Forest Experiment Station, August 3, 1931*

Hour of day	Wind velocity,[1] 150-foot level	Duff moisture			Moisture of wood—2-inch diameter			Air temperature			Relative humidity[2]		
		Open area	Half-cut area	Full timbered area	Open area	Half-cut area	Full timbered area	Open area	Half-cut area	Full timbered area	Open area	Half-cut area	Full timbered area
	Miles per hour	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*° F.*	*° F.*	*° F.*	*Per cent*	*Per cent*	*Per cent*
A. m.													
8:00	4							66	51	48	49	49	78
9:00	8	11	22½	25	5½	8½	10	78	64	52	28	30	42
10:00	13							84	78	73	21	22	24
11:00	12							88	82	77	16	16	16
Noon	13							90	86	81	13	13	14
P. m.													
1:00	15							91	87	84	11	11	11
2:00	17							91	88	86	10	10	11
3:00	18							90	87	86	10	10	12
4:00	15	4	8½	10	4	7	9	92	89	86	10	9	10
5:00	11							89	87	86	9	9	12
6:00	14							86	85	84	9	9	13
7:00	18							83	82	80	10	10	11
8:00	18							80	80	79	14	13	17
9:00	13							77	77	77	18	18	24
10:00	7							72	73	73	22	23	26
11:00	5							64	67	69	30	34	30
Midnight	6							53	60	65	52	45	41
Av. 11 a. m. to 9 p. m.	14.9							87.0	84.6	82.4	11.8	11.6	13.7

[1] The wind velocities shown above compare very closely with those recorded at a lookout station six miles away and at 6,000 feet elevation, thereby indicating that these velocities represent the regional winds in that locality on August 3, 1931.

[2] Slight inconsistencies in relative humidity data are due to: (1) Differences in temperature on the three sites; (2) differences in vapor pressure due to abundance of ground vegetation in the open, transpiring moisture; and (3) differences of sensitivity of recording instruments.

[1] Gisborne, H. T.: Meteorological factors in the Quartz Creek forest fire. Mon. Weath. Rev. 1927, LV, No. 2, pp. 56-60 (3 figs.).

The course of this conflagration was with the wind from a southwest to a northeasterly direction, in spite of various timber and fuel types, sharp ridges, valleys, cultivated fields, roads, and rivers. By the morning of August 4 an area 5 miles wide by 11½ miles long had been burned over, with several spot fires still farther ahead and as much as 15 miles from the point of origin. Over 20 of these spots were finally controlled before they burned together or backed to the main fire. The largest reached a size of 350 acres and was 3 miles ahead of the main fire.

This unusual rate of spread obviously points to the great importance of two factors; viz, extreme dryness of the fuel types, and wind as a propelling agent and carrier of blazing embers to start spot fires. These conditions as well as air temperature and relative humidity, are shown in Table I as they were measured at the Priest River station about 2 miles north of the fire. In considering these temperatures and humidities, they should be compared to the 20-year normal maximum temperature of 84.2° F. and the 5:00 p. m. relative humidity of 38 per cent for August 3 at this station.

These data show that when duff and wood moisture contents are as low as 4 or 5 per cent in the open and 9 or 10 per cent under dense timber, wind velocities of 12 to 18 miles per hour, together with maximum temperatures of 90° or 92° F., and humidities of 9 or 10 per cent result in possible spread of fire at about 1,600 acres per hour in northern Idaho.

When these conditions are compared with the measurements made by Gisborne in 1926, it is apparent that the difference between 1,500 acres per day and 1,600 acres per hour is due to what might have been considered as relatively small differences in fuel moisture, wind, temperature, and humidity. This comparison shows very closely, however, that these small differences combine to produce a most exceptional rate of spread of fire. This also demonstrates the importance of recognizing and forecasting temperatures of over 90° F., humidities around 10 per cent, coupled with winds of only moderate velocity, when the duff and slash moisture contents are under 5 per cent. At such times, every effort in control must be made if fires are to be reached and restricted before they grow to such great size as to require tremendous expense for their suppression.

EVAPORATION FROM LAKES AND RESERVOIRS

By C. E. GRUNSKY

[September 1931]

What has heretofore been published on the experimental data relating to evaporation must be used with caution. The United States Weather Bureau standard evaporation pan A, a land pan, does not furnish a satisfactory basis for comparing the evaporation from a large body of water in one place with that from another body of water in some other place. The same is true of most floating pans, nearly all of which have been insufficiently immersed. The Chestnut Hill Reservoir records by Desmond Fitzgerald[1] were obtained in part from a floating pan, the water in which sometimes differed as much as 10° F. from the outside water. The F. H. Bigelow experiments under direction of the United States Weather Bureau at Salton Sea with a battery of pans called floating pans were made with pans whose water surface was 3 or 4 inches above the surrounding water. These Bigelow records should not be credited to floating pans which should always have their water surface lower than that of the outside water. A new type of land pan with shaded rim is below suggested.

Wind effect on evaporation being taken into account the ordinary relation of evaporation to mean monthly air temperature is indicated in this contribution both in a table and by diagram. An altitude factor is suggested to be used until something better is found.

The writer desires to suggest the use of a type of land pan which will give results for some periods of time, such as the month, which will better indicate the relative amount of evaporation loss from widely separated large open-water surfaces. Furthermore, he presents some conclusions bearing on the relation of the mean monthly evaporation rate to mean monthly temperature, with inclusion of the effect on this rate of air movement and altitude.

The standard evaporation pan A of the United States Weather Bureau conforms substantially to the following description:

The pan is circular, 48 inches in diameter, 10 inches deep, and is filled with water to a depth of about 8 inches. It is built of galvanized iron and rests on wooden supports placed on the surface of the ground.

Pans of this character are widely distributed throughout the country and are intended to afford a basis for comparison of evaporation rates in different localities. The measurements of water loss from such pans with suitable correction factors are also supposed to serve as a dependable guide when evaporation from open water surfaces is to be approximated.

The standard pan seems to have been constructed with a view to giving maximum effect to the various factors which contribute to the rate of evaporation. Thus, for example, the sides and bottom of the pan are exposed to air, free circulation even under the pan being prescribed. The sides of the pan outside and inside have maximum exposure to sunshine. The result of this arrangement is that the water in the pan in sunshiny warm weather is materially warmer than the surface of a broad sheet of water would be, and in cold weather it cools off more rapidly. Moreover, the sunshine, which is practically continuous from sunrise to sunset at some places and very spasmodic at other places, falling upon the sides of the pan not only imparts heat to the water in the pan by transmission through the metal of which the pan is made and thereby accelerates evaporation, but the sides of the pan above the water frequently become quite hot and the wind ripples splashing up against and wetting these sides and evaporating therefrom unduly increase the water loss from the pan. When it is considered that an open body of water has only its surface exposed to the sunshine and air and that there are no vertical metal confining sides around small areas, then the inadequacy of this arrangement becomes apparent.

The heat of the sun imparted to the sides of the pan is not a factor that can be evaluated. Sunshine is not continuous; it is not the same from day to day. In the

[1] Transactions, Am. Soc. C. E., Vol. XV.

ideal pan its effect should, therefore, be reduced to a minimum.

The present type of standard land pan should be replaced by another conforming substantially to the following requirements. (See Fig. 1).

The pan should be circular, 4 feet in diameter. It should be placed in the ground with earth banked around it well above the surface of the water in the pan. The rim of the pan should carry an inverted V-shaped rider, the inner limb of which should come to within about 1 inch of the water surface. The purpose of this rider is to shield the side of the pan from the direct rays of the sun on the inside of the pan down to the water surface and on the outside down to the earth fill.

The water in the pan should be at least 15 inches and not more than 18 inches deep.

There should be a peg in the center of the pan with pointed top.

Observations should be taken daily, preferably at about 7 a. m. and at 2 to 3 p. m., of temperature of the air, of temperature of the water in the pan, of rainfall, and of wind velocity.

From time to time the pan should be refilled to the top of the peg. The refilling need not be daily. It should preferably be whenever the water has fallen one-eighth inch or more below the top of the peg.

Special observations should always be made when rain threatens and immediately after rain ceases to fall.

The observer should be provided with a standard cup preferably of such size that one cup full will represent, say, 0.02 or 0.05 inch of depth in the pan. He should be instructed to use full cups only in filling the pan and full cups only in bailing out the pan to the top of its peg.

Greater refinement will only then be required when observations are being made to establish the influence of some particular factor on the rate of evaporation.

The writer has had frequent opportunity of visiting so-called floating pans, the measured evaporation from which is intended to give a close approximation to the evaporation from an open water surface. These pans appear in almost every case to be improperly immersed in the surrounding water or to be otherwise of a type which defeats their purpose. Thus, for example, in the case of the evaporation studies made by Desmond Fitzgerald at Boston, he reports that sometimes the difference in temperature of the water in his floating pans and of the water surrounding these pans was as much as 10° F., and yet his record of evaporation has been generally accepted as classic, although what was wanted was the evaporation from water at the temperature of the surrounding water and not that from water at a different temperature.

The following information is taken from Mr. Fitzgerald's paper (Trans. A. S. C. E. Vol. XV, p. 596).

Referring to two small floating pans, the evaporation from which was measured during periods from 1876 to 1882 when the reservoir was not covered with ice, he says of certain observations taken every hour of the day and night, that these observations led him—

> * * * to infer that, owing to the varying temperatures of the water from hour to hour in the tanks as compared with the reservoir and the varying march of these changes according to the month of the year, little dependence could be placed on the value of the results for application under other conditions, unless some relation could be traced by more perfect conditions.

The large tank of the apparatus installed in 1884 for the more refined observations is thus described by him:

> In the center of the raft the tank "A", 10 feet in diameter and 10 feet deep, was immersed. This tank was made of staves of wood spaced 1 inch apart except where the hoops were located, so as to give free access for the outer water to the thin copper linine inside. Many holes were bored in the wooden bottom for the same purpose. It was expected that this would keep the water insidg the same, or nearly the same, temperature as that outside, but this was sometimes far from being the case. On one occasion the writer observed a difference of 10° F.

The flotation effect of the wood probably kept the water in the tank higher than the outside water.[3]

Again, Prof. F. H. Bigelow reported on the evaporation from a battery of pans of various sizes "floating" in water at the margin of Salton Sea, Calif. On investigation, however, it is found that his were not floating pans in the true sense. They were immersed pans with water intentionally held 3 or 4 inches higher than the surrounding water. The only influence of the surrounding water was to give some measure of temperature control. All of the heat in the hot rims of the pans above water went into evaporation from the pans and destroyed the value of the observations—a fact which should be made generally known.

As a rule, the so-called floating pans are, as in the case of the Bigelow pans, insufficiently immersed. The explanation given is that thereby more of the side of the pan is above the surrounding water and there is less likelihood of water being splashed into the pan. But all such insufficiently immersed pans show more water loss than a properly arranged floating pan would show. How much

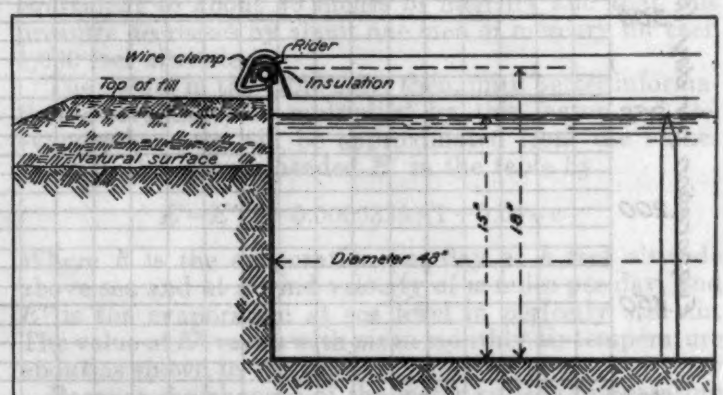


FIGURE 1.—Suggested type of standard evaporation pan

more? What correction factor to use? No one can tell, because sunshine is not dependable either as to duration or intensity. The correction factor would vary from day to day and from month to month.

Reference may be had in this connection to a comparison of evaporation records from two pans recently made, at the writer's suggestion, by the United States Army Engineers at Suisun Bay, Calif. Assistant Engineer C. A. Mees was in charge of these experiments. The evaporation from a pan insufficiently immersed which had been in use throughout the summer season was compared with the evaporation from a properly arranged floating pan during the two months October and November, 1930. It appears from the record that in these two relatively cool months, the pan which was insufficiently immersed showed 10 per cent more evaporation loss than the other.

The properly arranged floating pan will have its water surface at all times lower than the surrounding water. The heat which sunshine or warm air then puts into the sides of the pan above water will go into the outside water and will not contribute to a distortion of the evaporation rates. The floating pan might also to advantage be provided with an inverted V-shaped rim rider.

[3] See illustration, Transactions, Am. Soc. C. E., Vol. XV, p. 597.

The evaporation measured from such a floating pan, not less than 3 by 3 feet square or 4 feet in diameter, with not less than 15 inches of water, if placed well off shore in fairly deep water should be in reasonably close agreement with the actual evaporation from the surrounding water.

Enough has been said to show that very little dependence can be placed on most of the records which are ordinarily marshalled to evaluate coefficients for some evaporation formula or to show the influence of altitude, temperature, wind, and vapor pressure. It need only be added that the attempts to use ordinary meteorological data as elements in formulas when these formulas are based on some law of evaporation, have generally been failures. This results from the fact that it is impracticable to use long-time average values of the controlling factors in place of these factors as variables in formulas which should be integrated from minute to minute, or possibly at most from hour to hour. It follows that practically all that has been written on the subject of the loss of water from lakes and reservoirs by evaporation must be read with caution and recourse must be had to original data to determine how it may be used, if at all. Not even the records of floating pans, as above stated, can be accepted without question, because the "floating pan" may be and probably is merely a pan suspended in water or it may be a pan floating in shallow, marginal, inordinately warm water.

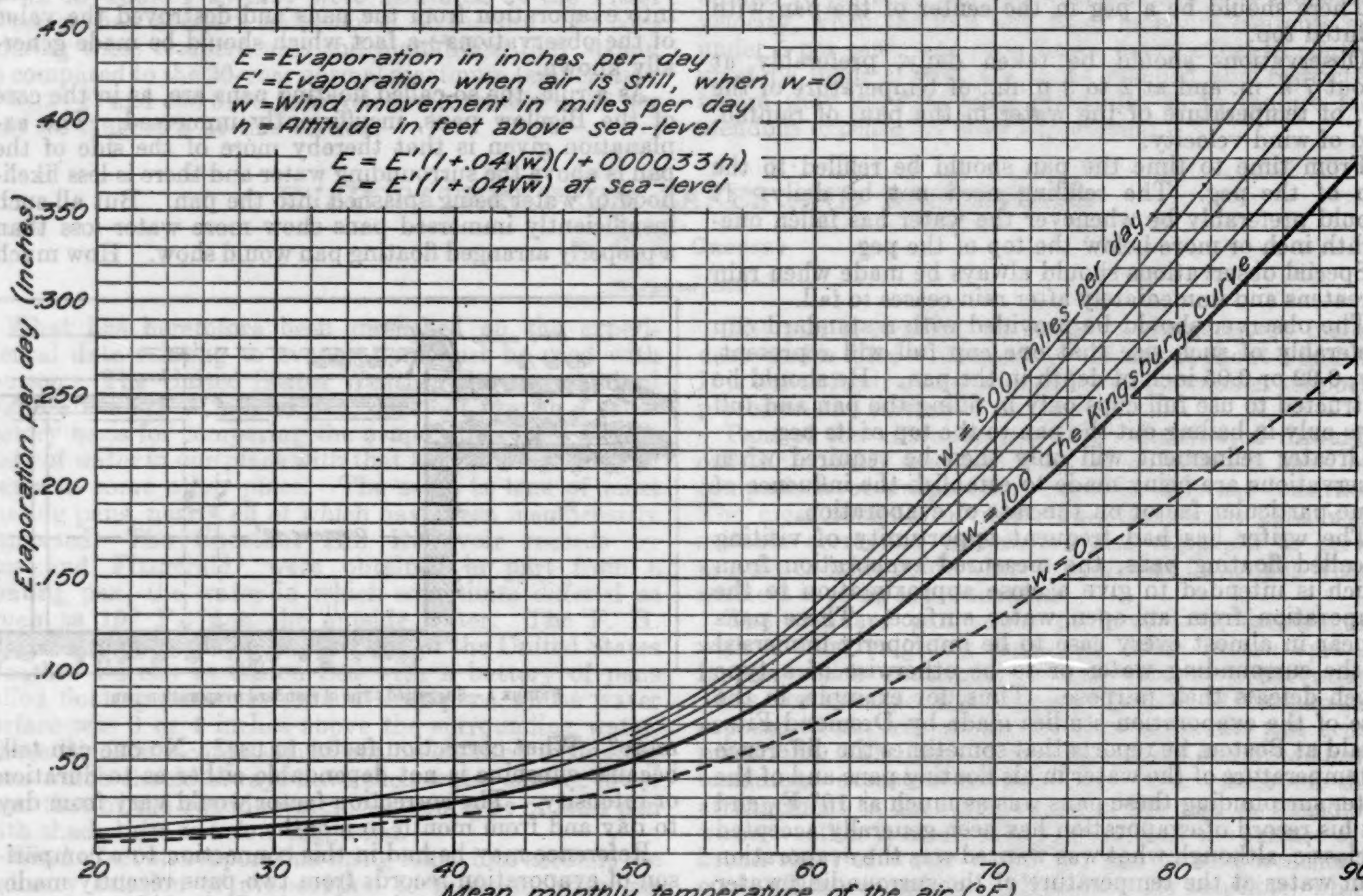


FIGURE 2.—The observations at Kingsburg, Calif., on which these curves are based, covered a 4-year period 1881-1885
Two pans, each 3 feet square were used, one a land pan, embedded; the other a pan floating in Kings River
The mean annual evaporation from the land pan was 4.86 feet, from the floating pan 3.85 feet
Conditions were such that the floating pan must have indicated somewhat less evaporation and the land pan materially more than that from a large open water surface. Consequently, the probable monthly evaporation rates from open water for Kingsburg climatic conditions were approximated by giving the floating pan record three times the weight of the land pan record.

Because of uncertainty of hours and intensity of sunshine and because of wide variation in wind effect, which is sometimes excessively accelerated by the splashing of water ripples against heated sides of the pans, the Weather Bureau's standard pans do not fairly indicate relative evaporation rates throughout the country. This statement is repeated because this fact can not be too strongly emphasized. It has, heretofore, been generally ignored. These pans, for the same reason, do not correctly indicate for their own stations the relative amount of evaporation month by month. Consequently, no correction factor applicable to the records established by such pans which would fairly approximate actual water surface evaporation can be found. It does not exist.

There are in California alone some 20 or more points at which evaporation from pans is being measured. Of the resulting records comparatively few will be helpful in a study of the relation of the rate of evaporation from a large open water surface to the known meteorological conditions.

The evaporation from pans buried in the ground as above described would serve the purpose of comparison much better and would also be helpful in throwing some needed light on wind effect.

When Professor Bigelow was making his experiments at Salton Sea, the writer tried to have him devote some attention to the determination of the relation of evaporation to ordinary meteorological conditions, such as mean monthly temperature, daily temperature range, relative humidity, and wind movement, but without success. And yet all experiments thus far made show conclusively that mean air temperature, for some period of considerable duration, such as a month, is frequently a fair index of the rate of evaporation from a water surface. This is due largely to the fact that changes in water-surface temperature will follow air-temperature changes, and water-surface temperature is a major factor of influence on the rate of evaporation. Next in influence is the wind movement. Wind movement is generally 100 to 200 miles per day. No great error would be made if its departure in a single month from ordinary wind movement were ignored. This fact has led many engineers in estimating evaporation to the use of curves which show the probable unmodified relation of evaporation to the mean monthly temperature. This is equivalent to assuming, when better information is lacking, uniformity of aggregate wind movement throughout each month of the year. It is astonishing how well such a curve will meet ordinary requirements, when annual evaporation alone is in question.

However, it is frequently desirable to approximate more closely the evaporation during the individual months. Suppose, now, that observations have supplied sufficient basic data to establish the relation between evaporation and temperature for an observed wind movement in some time period, such as a month, then the basic rate of evaporation for no wind can be fairly well approximated by use of a formula of the type

$$E=E'(1+.04\sqrt{w})$$

Here E is the evaporation rate in feet per day when the wind movement is w miles per day and E' is the evaporation in feet per day for no wind movement. Wind should be introduced in this equation as measured above ground, without reduction to air movement at the water surface. It follows that

$$E'=\frac{E}{1+.04\sqrt{w}}$$

TABLE 1.—*The relation between evaporation from an open water surface and mean monthly temperature*

[Based in the main on the State engineer's observations at Kingsburg, Calif., 1881-1885]

[The average monthly wind movement at Kingsburg is about 3,000 miles or 100 miles per day. w=miles of wind movement in 24 hours. The figures in the table indicate the probale average daily evaporation during months with mean temperatures as noted in the first column]

Mean monthly air temperature, degrees, Fahrenheit	At Kingsburg, evaporation in inches per day		Computed evaporation $E=E'(1+.04\sqrt{w})$, inches per day			
	Measured w=100	Estimated w=0	w=200	w=300	w=400	w=500
20	(0.0091)	0.0065	0.0102	0.0110	0.0117	0.0125
25	(.0126)	.0090	.0141	.0152	.0162	.0170
30	(.0161)	.0115	.0179	.0194	.0207	.0217
35	(.021)	.0150	.0235	.0254	.0207	.0284
40	.028	.0200	.0313	.0338	.0360	.0378
45	.037	.0265	.0415	.0448	.0477	.0501
50	.050	.0360	.0565	.0608	.0648	.0680
55	.070	.0500	.0783	.0845	.0900	.0945
60	.099	.0705	.110	.119	.127	.133
65	.136	.097	.152	.164	.175	.184
70	.178	.127	.199	.215	.229	.240
75	.224	.160	.250	.271	.288	.302
80	.274	.196	.307	.332	.353	.371
85	.325	.232	.364	.392	.418	.438
90	.378	.270	.423	.457	.486	.510

Based on the Kingsburg, Calif., evaporation records (see Transactions, Am. Soc. C. E., Vol. LXXX, pp. 1968 to 1983) the writer has used with much satisfaction the relation expressed in Table 1 and shown in Figure 2, between mean monthly temperature and the mean rate of evaporation, modified by the influence of wind. In individual months, due to unusual conditions of humidity and other factors, some wide departures are still to be expected. The indicated annual in any computation based on the table is believed to be fairly dependable, particularly if an altitude factor be introduced.

The rate of evaporation is unquestionably affected by air pressure. Evaporation increases as air pressure decreases. For the same temperature and wind conditions it will be greater at high altitudes than at sea level. Russell[3] has suggested that this increase is inversely proportional to atmospheric pressure on the surface of the water. According to this conception the altitude factor might be written

$$\frac{30}{30-\frac{h}{1000}} \text{ or } \frac{30000}{30000-h}$$

or near enough $1+0.000033\ h$ where h is the altitude above sea level in feet. This expression is based on the well-known fact that atmospheric pressure at sea level is equivalent to about 30 inches of mercury and that this pressure decreases by about one inch of mercury for each 1,000 feet altitude.

The values in the table may, then, until better information is available, be multiplied by this factor and the evaporation rate will be approximated from the values given in the column headed E' in the table by

$$E=E'(1+0.000033h)(1+0.04\sqrt{w})$$

Where E is the evaporation per day at h feet altitude above sea and at a wind velocity of w miles per day, and E' is the evaporation at sea level in perfectly still air. The value of E' varies with mean monthly air temperature about as shown in the table.

Because the changes of the water surface temperature lag behind the changes of air temperature, the relation shown in the table between mean air temperature and evaporation has no application to short time periods such as an hour, a day, or a week. Even in the case of a 30-day period probability rather than close approximation is indicated. It follows that the principal use of the table should be to determine annual evaporation from mean monthly air temperature, wind movement during the month, and altitude.

The values presented in this table and as shown by the curves may be used with confidence to establish with sufficient approximation for ordinary purposes the annual evaporation from open water surfaces wherever located. In the case of shallow ponds where water temperature is relatively high the evaporation may be considerably larger than the figures in the table would indicate. Where humidity is unusually high the evaporation will probably be less than that given in the table.

It is interesting to note that the use of the table or the curves with introduction of the altitude factor will indicate a probable annual evaporation: For climatic conditions similar to those on the Isthmus of Panama a little more than 7 feet, which is probably in excess of the actual fact; for the Salton Sea in southeastern California, about 6.2 feet; for Lake Superior, about 17.1 inches;

[3] T. Russell, Asst. Prof. U. S. Signal Corps. See MONTHLY WEATHER REVIEW, September, 1888.

for Lake Michigan-Huron, about 24.7 inches; for Lake Erie, about 30 inches; for the vicinity of Boston, about 28.5 inches; for Lake Tahoe, Calif., (altitude 6,230 feet) about 22 inches; for Great Salt Lake, Utah (altitude 4,200 feet) about 26 inches.

DISCUSSION

By C. F. MARVIN

Perhaps there is no measurement of a meteorological phenomenon concerning which there is greater diversity of view than prevails with reference to evaporation from free water surfaces. The Weather Bureau, in choosing the present so-called standard type of evaporation pan, fully considered practically all the faulty characteristics pointed out by Mr. Grunsky.

In reaching our decision we are compelled to recognize that the observations must be continued, not for a few weeks or months, but over periods of several years of time, and under the care of observers who are often conscientious enough but, nevertheless, lack the highly trained character of engineers or laboratory physicists whose minds are always alert, as to sources of error and fallacious records. In the case of pans floating in water or pans buried deeply in the ground, it is almost surely a question only of time before an insidious leak develops in the seams, or even in the body of the pan itself, out of which water passes in unknown quantities, always measured as so much evaporation. Maintenance of a proper condition of cleanliness is difficult, unless the pan can be thoroughly washed and rinsed, a process much simplified when the water can be poured out.

Mr. Grunsky's criticism that the Weather Bureau type of pan is so freely exposed to the air, even underneath, that its temperature fluctuates widely, is true, but this construction is one that permits of the discovery of leaks and faults of the apparatus that perhaps might otherwise escape the notice of a careful observer.

Moreover, the conditions that surround the standard Weather Bureau pan undoubtedly lead to a larger quantity of evaporation than that representing conditions over large, free surfaces of reservoirs, lakes, etc. However, this larger evaporation admits of a more accurate measurement, and its subsequent correction is a subtractive reduction of the actual observation, involving in principle a greater accuracy than would otherwise be the case; that is, the engineer in using these data is on the safe side, inasmuch as the evaporation may be really less than that estimated from the observations.

While these remarks are applicable to the Weather Bureau practice, there is a full realization of the decided advantage of making evaporation measurements that require no consequential correction of any kind. However, this concept presupposes that the evaporation characteristic of a given climate is a definite and constant thing for all possible utilization, such, for example, as the water losses from open reservoirs, water losses from vegetation by transpiration, forest cover, etc. Each of these uses of the evaporation characteristic of a given locality is contemplated in the data being collected by the Weather Bureau, and while our results may have a limited value for determining the exact evaporation from a free reservoir surface, they may have greater value for other uses.

RELATIVE FREQUENCY OF CENTERS OF CYCLONES AND ANTICYCLONES IN THE UNITED STATES

ERIC C. MILLER
Weather Bureau, Madison, Wis.

Cyclones and anticyclones are difficult to deal with statistically, hence have not received attention in proportion to their importance as climatic elements. This paper attempts what may be called a "census" of the number of centers that appear in each 5° square of latitude and longitude, at the 8 a. m. and 8 p. m. (eastern standard time) observations, per month and per annum.

In order to eliminate the varying lengths of the months, the monthly data have been reduced to the number of occurrences per 1,000 observations. For the year, the number of centers per annum per 5° square are given here.

The monthly and annual statistics have been entered at the center of each square, and lines of equal frequency drawn. Graphs showing the march of frequency through the year have also been drawn for each square, and these have been transferred to maps of the United States on the Mercator projection, so that each square is of the same width in longitude.

Before enumerating the results of this study, it must be pointed out that these statistics differ from those of Garriott (1) and Kullmer (2), which show the number of centers that passed across the individual squares. The present paper counts only those centers that were in the square at the two daily observations.

The charts and graphs accompanying this paper show that—

(1) The number of centers, of both cyclones and anticyclones, is greater in the interior of the continent than around the margins. Mark Twain, in a famous after-dinner speech (3) has called attention to the variability of New England weather. These charts show more than twice as many centers over the Great Lakes and the Plains as in New England. Success in weather forecasting (4) is negatively correlated with the number of centers, and is at a minimum in the Lake region.

(2) A center of maximum frequency of cyclones exists in Saskatchewan at all seasons.

(3) There is a maximum of frequency of cyclones in the Lake region in July and August, in the West Gulf States in January. The intervening States show two maxima, one in spring, another in autumn, corresponding to the popular tradition of the "equinoctial storm," and also to two maxima of rainfall; e. g. in eastern and southern Wisconsin. Whether there is continuous travel of a "polar front," or tendency to steep temperature gradients, back and forth from the 30° parallel to the 50° parallel of latitude, may be worth investigating.

(4) In winter, a loop of maximum frequency of anticyclones extends from Saskatchewan to the southern Appalachians.

(5) Centers of anticyclones have a maximum of frequency in Oregon and Washington in summer, when the semipermanent anticyclone in the Pacific is at its greatest intensity.

(6) Maxima of frequency of anticyclones appear successively in contiguous regions as follows: July to

September in the Missouri Valley, Central Rocky Mountains in October and November, and in the northern Plateau region in December and January. The high frequency in October in the Southwest is especially noteworthy, and its cause needs investigation.

(7) The Great Lakes have a well-defined maximum of anticyclones in August, when the lakes are cooler than the surrounding lands, and a minimum in winter when warmer than the surrounding lands. The influence of these lakes on cyclones and anticyclones has been discussed by Cox (5).

(8) The all-year minima of frequency of both kinds of centers in California, Florida, and along the southwestern border from Texas to Arizona, are important climatic influences in making those regions winter resorts.

The data used in this paper were obtained from the well-known papers by Bowie and Weightman on types of storms and of anticyclones of the United States and their average movements (6, 7) for the 21 years 1892–1912 inclusive. In the papers of Bowie and Weightman, the centers were kept separate according to region of origin, and their "types" refer to region of origin. Here all types have been added together, hence there remains in the present paper no differentiation with respect to type. All that is assumed is that Bowie and Weightman included all centers in their statistics. Nothing of their method of compounding 24-hour movements of centers to obtain the average movement enters into the present paper. It seems important to emphasize these points, inasmuch as Garriott (1) drew a free-hand curve through the squares having the greater number of cyclones passing through them, determining branches and branch points more or less arbitrarily. These so-called "storm tracks" have enjoyed a vogue entirely out of proportion to their merit. Bigelow (8) published maps of storm tracks, apparently without any numerical basis. Van Cleef (9) has shown by the logical process of *reductio ad absurdum* that there is no type storm and no typical storm track, but his charts have been used by others as illustrations of typical storm tracks. Let it be understood, then, that this paper deals solely with the "census" of centers of cyclones and anticyclones, on the basis of observations twice a day, during the 21 years, 1892–1912 inclusive. The monthly charts have been reduced to the number of centers per 5° square per 1,000 observations by dividing the observed numbers by 1,302 for 31-day months, 1,260 for 30-day months, and by 1,186 for February. The graphs of march of frequency show the same data as the monthly charts. The charts of annual totals have been reduced to a basis of one observation per day by dividing the totals for 21 years by 42.

TABLE 1.—*Relative frequency of centers of cyclones pro mille of observations per 5° square*

Latitude	Longitude	January	February	March	April	May	June	July	August	September	October	November	December
° °	° °												
50-55	80-85	2	1	----	----	1	2	2	2	1	4	3	0
	85-90	6	6	5	----	2	2	12	5	9	8	5	4
	90-95	5	6	5	4	5	6	19	12	6	8	11	7
	95-100	26	18	18	17	15	17	27	27	29	28	24	28
	100-105	35	27	17	25	25	36	31	±1	36	32	39	35
	105-110	40	32	28	33	33	44	32	35	38	41	42	45
	110-115	48	44	45	48	40	56	36	35	44	46	53	58
	115-120	27	24	24	30	18	27	18	25	28	30	31	33
	120-125	10	14	18	13	9	5	6	11	17	15	21	21
45-50	60-65	2	2	2	----	----	2	----	1	0	3	4	0
	65-70	11	8	11	9	8	13	15	10	1	12	10	10
	70-75	19	1	12	10	18	31	26	28	12	20	17	12
	75-80	34	20	22	21	24	21	34	38	24	21	29	27
	80-85	43	26	24	22	31	23	31	41	28	41	44	41
	85-90	44	34	28	38	36	38	49	52	48	48	49	45
	90-95	27	22	21	28	17	36	32	38	34	35	35	33
	95-100	28	19	22	28	26	33	38	40	40	34	38	31
	100-105	20	10	14	21	21	45	35	39	33	26	22	19
	105-110	13	14	24	20	22	25	31	37	31	23	20	15
	110-115	16	12	12	17	24	18	13	24	14	9	19	12
	115-120	13	4	8	13	12	10	12	16	11	5	21	6
	120-125	27	24	25	14	8	9	0	2	7	15	27	26
	125-130	27	19	15	5	5	2	0	0	6	10	24	25
40-45	60-65	8	7	+1	2	1	2	0	0	0	3	4	2
	65-70	18	17	10	7	8	3	8	7	0	15	21	24
	70-75	17	11	21	22	18	6	15	8	6	25	31	24
	75-80	25	27	15	23	18	20	14	15	11	17	21	20
	80-85	36	31	35	32	17	25	19	19	10	20	29	31
	85-90	27	31	26	40	38	21	25	23	21	18	40	30
	90-95	27	19	40	39	40	28	22	32	29	40	34	25
	95-100	21	19	28	37	41	39	28	46	41	39	25	19
	100-105	22	16	27	39	31	40	28	33	31	29	25	19
	105-110	20	18	18	20	27	13	8	8	16	8	25	12
	110-115	11	12	15	15	24	14	19	15	20	11	15	5
	115-120	5	8	12	11	15	3	6	9	14	8	5	4
	120-125	8	12	10	8	2	6	2	4	5	8	10	5
	125 130	3	3	6	2	----	1	0	0	0	2	4	5
35-40	65-70	5	2	4	2	1	2	1	2	0	5	0	4
	70-75	15	27	15	14	8	9	3	4	1	8	25	20
	75-80	15	21	15	20	15	13	5	5	3	6	17	21
	80-85	16	18	14	18	13	12	5	4	8	7	10	14
	85-90	22	35	24	20	12	13	5	8	±7	4	23	31
	90-95	27	30	28	28	21	16	8	12	13	14	37	41
	95-100	20	43	46	46	46	28	26	19	25	31	42	27
	100-105	35	44	49	64	46	32	18	18	26	12	37	25
	105-110	12	22	41	38	29	15	7	8	10	20	16	15
	110-115	15	24	21	23	24	6	8	2	8	15	10	14
	115-120	5	13	10	10	11	6	4	2	4	6	6	4
	120-125	3	6	6	2	0	1	0	4	2	3	3	2
30-35	70-75	5	16	2	2	0	1	1	0	0	4	6	2
	75-80	15	12	7	6	5	3	5	1	1	8	12	8
	80-85	9	15	14	12	7	6	7	1	4	6	17	9
	85-90	23	29	17	13	10	5	2	6	8	7	20	23
	90-95	30	35	20	16	11	5	3	6	7	5	22	31
	95-100	30	31	28	25	11	17	5	3	4	4	23	34
	100-105	21	24	19	13	15	2	+0	3	0	12	10	16
	105-110	6	19	12	13	15	2	0	0	0	7	6	12
	110-115	15	18	15	10	17	2	2	2	2	8	10	14
	115-120	5	6	2	2	2	0	0	0	0	1	2	2
	120-125	2	2	2	0	0	0	0	0	0	0	0	0
25-30	70-75	1	7	0	0	0	0	0	0	0	2	2	0
	75-80	3	3	0	1	4	0	0	1	0	7	2	0
	80-85	9	8	5	1	5	0	0	1	1	5	4	4
	85-90	12	13	3	3	1	2	2	2	7	4	4	10
	90-95	13	24	8	8	3	3	1	2	6	4	7	18
	95-100	35	33	25	13	8	2	0	0	5	9	13	34
	100-105	3	7	2	2	3	0	0	0	0	2	3	4

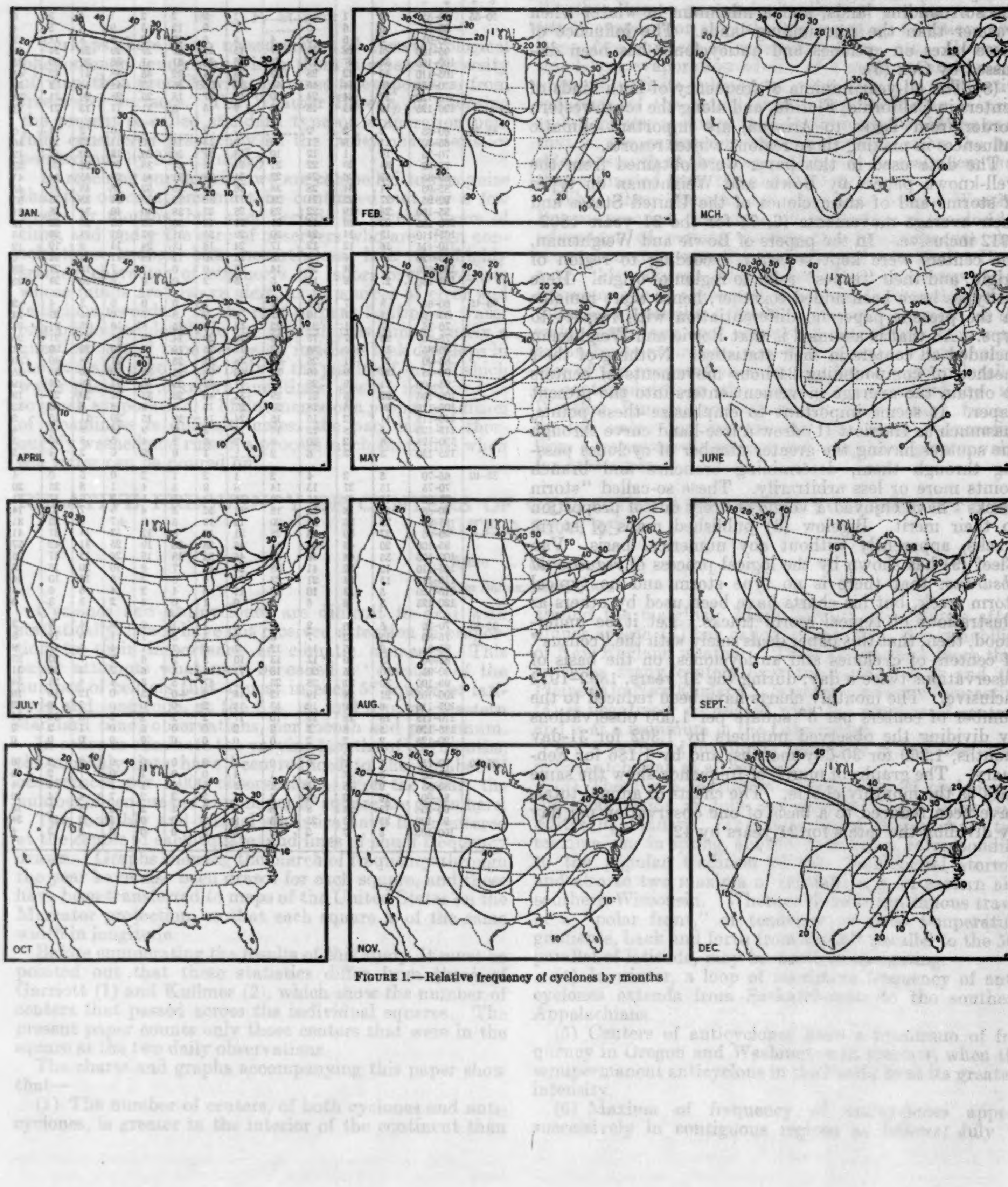


FIGURE 1.—Relative frequency of cyclones by months

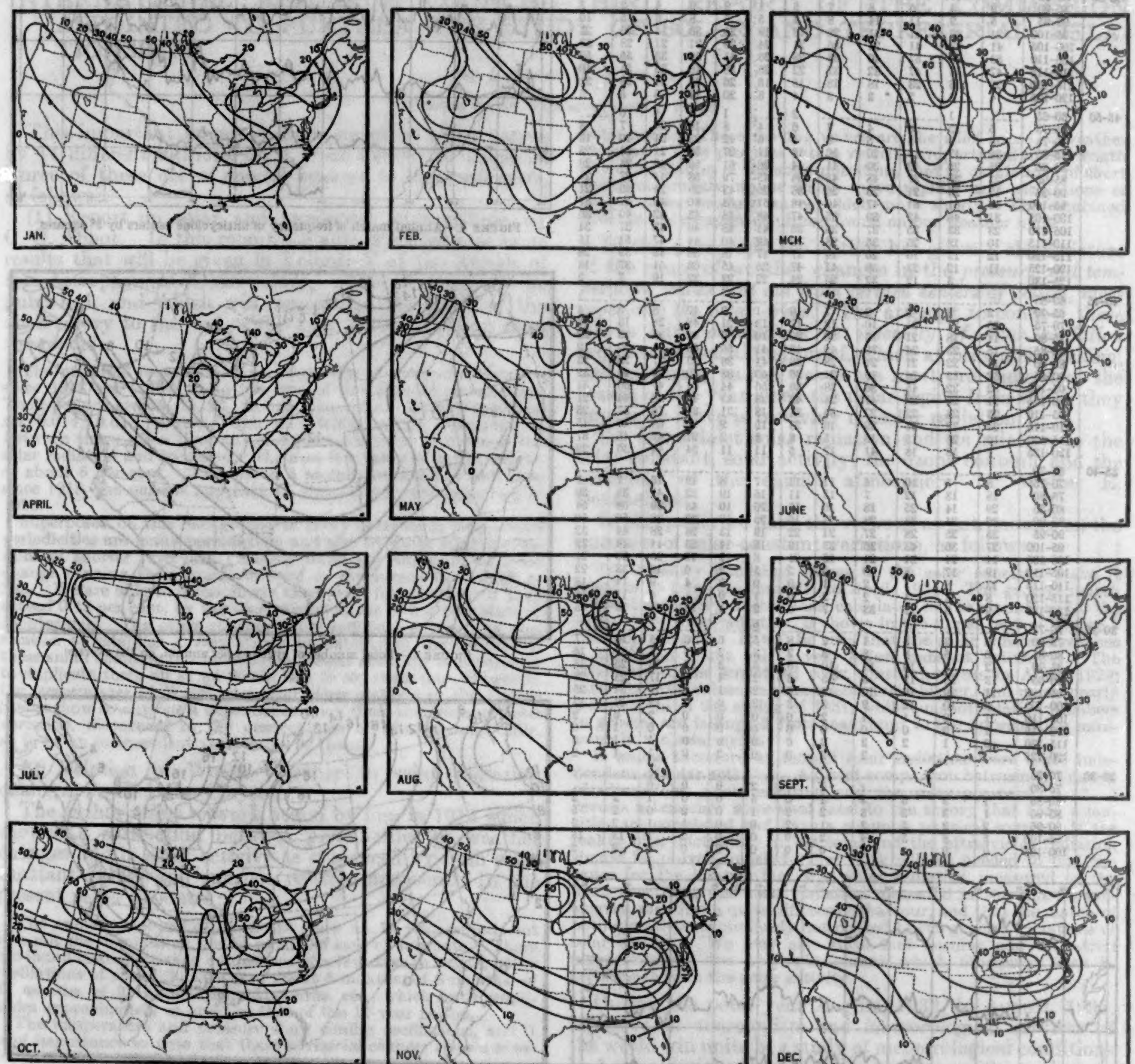


FIGURE 2.—Relative frequency of anticyclones by months

TABLE 2.—*Relative frequency of centers of anticyclones pro mille of observations per 5° square*

Latitude	Longitude	January	February	March	April	May	June	July	August	September	October	November	December
° ° 50-55	° ° 80-85	5	-----	1	4	4	3	0	1	2	7	0	2
	85-90	9	3	6	8	7	6	1	9	9	4	2	7
	90-95	5	9	11	14	8	4	5	5	8	6	5	10
	95-100	24	32	31	31	28	16	19	25	30	14	26	27
	100-105	41	33	41	24	36	21	24	28	31	21	28	33
	105-110	53	56	57	40	33	28	26	41	58	35	55	59
	110-115	47	51	47	32	32	22	26	38	46	35	54	40
	115-120	20	16	23	18	18	15	16	26	36	24	29	21
	120-125	4	3	2	3	3	4	8	20	14	5	5	5
45-50	60-65	-----	1	-----	-----	-----	2	-----	1	1	4	0	-----
	65-70	5	12	6	4	7	6	4	8	14	24	7	8
	70-75	16	9	8	5	8	5	6	12	23	21	10	13
	75-80	26	17	15	20	16	16	11	27	36	21	14	25
	80-85	25	25	42	39	41	44	26	61	53	40	24	26
	85-90	23	30	37	48	45	56	45	79	58	41	27	25
	90-95	12	24	21	25	25	36	29	43	29	24	30	21
	95-100	85	51	61	47	46	48	51	58	60	46	51	57
	100-105	31	48	43	39	35	47	48	48	43	42	40	36
	105-110	23	33	35	37	38	36	41	48	48	43	37	34
	110-115	10	18	25	35	28	30	42	40	44	47	51	15
	115-120	12	13	10	26	14	17	17	18	36	45	39	28
	120-125	11	12	23	58	41	47	36	45	63	54	37	18
	125-130	-----	3	12	32	25	24	22	22	32	19	7	2
40-45	60-65	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
	65-70	2	3	2	2	7	10	1	9	17	8	5	4
	70-75	25	21	21	10	12	17	13	21	48	28	13	16
	75-80	11	18	21	13	20	20	19	36	42	35	13	22
	80-85	15	23	24	30	40	46	41	56	43	51	29	12
	85-90	14	22	21	24	28	38	41	36	35	27	25	23
	90-95	32	35	24	19	21	36	40	35	39	32	44	32
	95-100	32	32	45	36	38	36	56	44	61	47	36	31
	100-105	21	26	38	47	28	42	38	51	49	48	44	21
	105-110	23	23	22	27	34	34	18	31	39	75	57	25
	110-115	24	32	21	29	16	23	15	9	26	68	49	45
	115-120	16	25	15	15	5	8	8	2	21	42	45	37
	120-125	7	13	18	41	17	5	11	11	34	44	36	29
35-40	65-70	-----	-----	-----	-----	2	-----	-----	-----	-----	-----	-----	-----
	70-75	8	5	10	4	11	13	7	8	19	16	7	7
	75-80	18	13	12	7	12	11	15	19	32	41	38	39
	80-85	29	14	25	18	16	17	20	10	46	39	58	54
	85-90	30	24	33	28	23	16	25	10	32	38	50	50
	90-95	25	25	28	27	21	22	19	13	28	28	44	32
	95-100	27	30	43	36	33	19	18	14	25	41	44	32
	100-105	14	24	21	21	15	21	8	12	19	25	36	21
	105-110	19	17	8	10	5	5	5	2	6	16	33	22
	110-115	13	8	7	2	1	0	0	0	4	9	14	18
	115-120	8	4	4	2	2	0	1	0	1	4	11	18
	120-125	9	8	12	33	7	6	2	4	13	14	10	15
30-35	70-75	-----	-----	-----	-----	-----	-----	2	-----	-----	-----	-----	-----
	75-80	6	3	4	1	2	8	5	0	6	4	10	7
	80-85	6	5	6	8	3	2	3	2	9	7	17	16
	85-90	12	8	10	11	10	6	5	3	19	12	25	18
	90-95	13	13	12	6	5	6	2	4	9	17	23	23
	95-100	11	20	16	10	6	10	2	1	7	17	34	25
	100-105	6	10	12	9	3	3	2	0	2	12	17	13
	105-110	1	2	1	1	2	0	0	0	0	2	6	2
	110-115	1	0	0	0	0	0	0	0	0	0	1	0
	115-120	0	1	2	2	2	0	0	0	0	1	1	3
	120-125	-----	-----	-----	2	2	0	0	2	0	1	1	2
25-30	70-75	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
	75-80	-----	-----	-----	-----	1	-----	2	0	0	0	-----	-----
	80-85	1	3	3	3	1	0	5	0	0	1	2	2
	85-90	1	3	3	3	2	2	1	0	2	0	2	5
	90-95	2	3	5	3	1	2	0	0	1	1	2	6
	95-100	5	8	3	4	2	0	0	0	2	1	13	15
	100-105	0	0	1	0	0	0	0	0	0	0	2	2

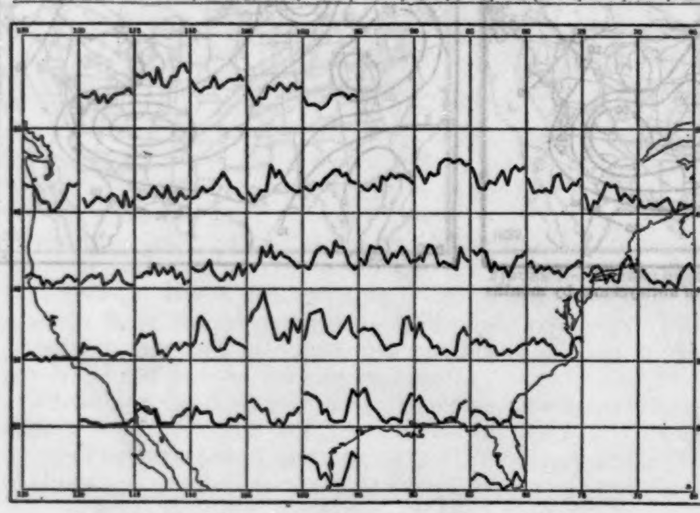


FIGURE 3.—Annual march of frequency of cyclone centers by 5° squares

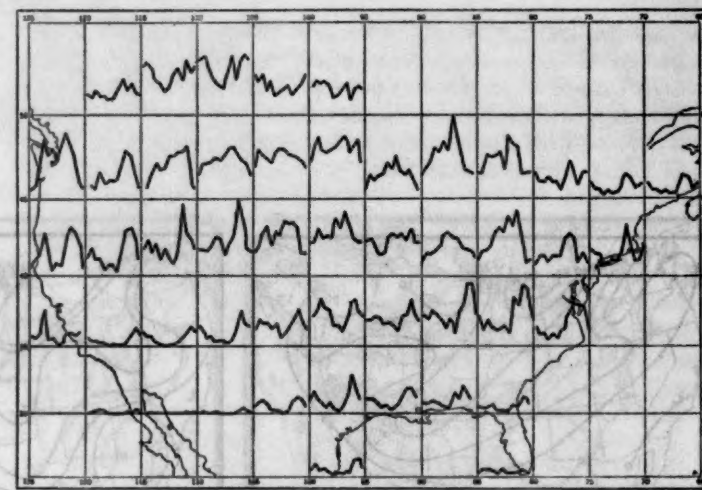


FIGURE 4.—Annual march of frequency of anticyclone centers by 5° squares

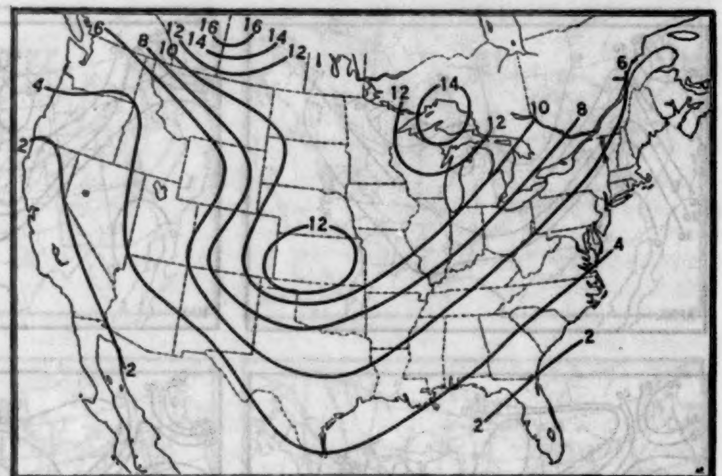


FIGURE 5.—Total number of cyclones per annum, on the average

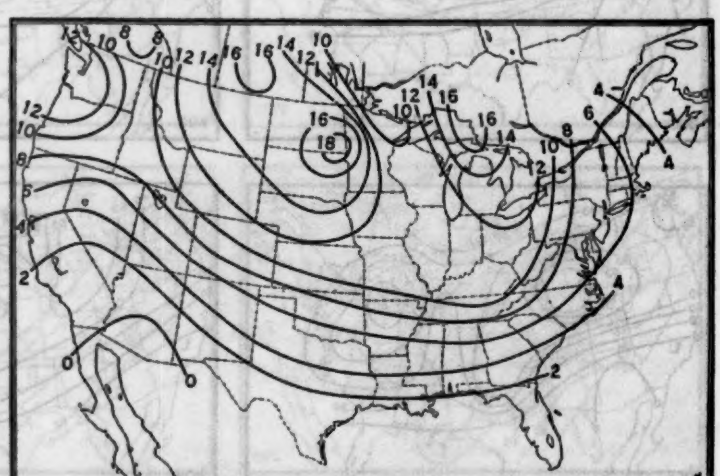


FIGURE 6.—Total number of anticyclones per annum, on the average

LITERATURE CITED

(1) United States Weather Bureau, Bulletin A. Summary of International Meteorological Observations, charts 40 to 52. Washington, 1893.

(2) Kullmer, C. J. The shift of the storm track, in Huntington, E. The climatic factor as illustrated in arid America. Carnegie Inst. of Wash. Pub. No. 192. 1914.

(3) Twain, Mark. The Weather of New England. In Writings of Mark Twain, Harper & Bro. Vol. 20, pp. 392–395.

(4) Marvin, C. F. Verification of forecasts, Rept. Chief of the Weather Bureau, 1919-20, p. 11.
(5) Cox, H. J. Influence of the Great Lakes upon movement of high and low pressure areas. Proc. 2nd Pan Am. Sci. Cong., v. 2, p. 432, Washington, 1917.
(6) Bowie, E. H. and Weightman, R. H. Types of storms of the United States and their average movements. Mo. Wea. Rev., Supp. No. 1, Washington, 1914.
(7) Bowie, E. H. and Weightman, R. H. Types of anticyclones of the United States and their average movements. Mo. Wea. Rev., Supp. No. 4. Washington, 1917.
(8) Bigelow, F. H. Storms, storm tracks, and weather forecasting. United States Weather Bureau Bull. 40, Washington, 1897.
(9) Van Cleef, E. Is there a type of storm path? Mo. Wea. Rev., v. 36, 1908, pp. 56-58 and charts 9-18.

INTERNATIONAL RESEARCH COUNCIL—THIRD REPORT OF THE COMMISSION APPOINTED TO FURTHER THE STUDY OF SOLAR AND TERRESTRIAL RELATIONSHIPS

By HERBERT H. KIMBALL

[Weather Bureau, Washington, February 3, 1932]

This important report is made up of 40 short papers by 44 different authors, on a great variety of subjects. Three of these are of special interest to meteorologists, as follows:

(1) Report on solar and terrestrial relationships, by C. G. Abbot. In this report the author anticipates some results that will be given in Volume V of the Annals of the Astrophysical Observatory, which is soon to be published, and which will summarize the work of the observatory to the end of the year 1930. Quoting from the report:

The principal features and many details of the sun's variation since 1918 are found to be the sum of five regular periodicities. Their periods are 65, 45, 25, 11, and 8 months. Their amplitudes are 0.014, 0.013, 0.010, 0.009, and 0.005 calorie, respectively. Between times when they all reinforce each other to increase the solar radiation and to decrease it, there is a range of 0.102 calorie, or about 5 per cent. This was not entirely reached at any time since 1918, the nearest approach of about 3 per cent occurring in 1922.

Superposed on this background of fairly permanent long-period periodicities are many periodicities and also irregular solar fluctuations of shorter intervals. Among these are sequences of solar change running their course upward or downward in a week or less. We are able to discriminate these with fair certainty if they exceed 0.45 per cent, by the daily observations of our best station, Montezuma. The other stations show sufficient evidence of correlation to establish a very strong probability of the veridity of these small changes, but have not sufficient accuracy or continuity to duplicate them all as we would like to see them do. However, the *temperatures* of Washington and other stations in the United States show so obvious a dependence upon these sequences of solar variation, discovered in the observations of Montezuma, Chile, as to be an independent verification of them.

(2) Relation of World Weather to solar radiation changes, by H. Helm Clayton.

The author refers to work begun by him in 1916 which showed a correlation between periodicities in weather changes and in solar activity as evidenced by both solar constant values and sunspot relative numbers. In the present paper he states:

The annual solar variation means show an 11-year period, but it is not the dominating period as in the case of sunspots. There are found instead marked oscillations of a few days in length, other oscillations of about 30 weeks, of about 5 months, of 8 months, of 11 months, of 22-28 months, 45 months, etc., which have amplitudes approximately as great as that of the 11-year period.

The temperature and pressure show similar oscillations, and it is of importance to note that these *terrestrial changes show a similarity to solar radiation changes and not to sunspot curves.*

The short periods found approximate to fractions of the 11.25 year sunspot period or the double sunspot period of 22.5 years. It is hence assumed that they are harmonics of this longer period.

For a summary of Clayton's paper we will quote the following paragraph:

MOVING WAVES OF WEATHER

The disentangling of solar influences is rendered very difficult by the discovery that following oscillations in intensity of solar radiation something in the nature of pressure and temperature waves are sent out from certain centers of action, more especially from the polar areas. These moving waves are the chief cause of weather changes. They progress with a velocity proportional to the length of the oscillation of the solar pulsation, that is, oscillations of short duration produce waves which move rapidly and oscillations of long duration produce waves which move slowly. The combined effect is the complex condition found on our weather maps.

In this paragraph the author has given a clear picture of the cause of weather changes in the *pressure and temperature waves sent out from certain centers of action, more especially the polar areas.* The attempt to connect these waves with *oscillations in intensity of solar radiation* requires observational proof, which at present is lacking, and especially as the waves are most pronounced at the season of the year when the polar region from which they appear to move is receiving no solar radiation.

(3) Ultraviolet solar radiation and its relation to the solar constant, solar activity, the ozone content, and the turbidity of the earth's atmosphere, by Walter E. Bernheimer.

In this paper we have the views of an astronomer on the question of solar-constant variations, as follows:

The recently published values of the solar constant make it possible to treat the material to April, 1931. The general march without secondary fluctuations, calculated in like manner as for the ultra-violet solar radiation, is shown in the upper part of Figure 2 (not reproduced). It will be seen that the solar constant reaches a maximum about half a year before sunspot maixmum. The minimum of the smoothed solar constant occurs in April, 1929; after that the values become successively higher, and reach nearly a maximum in the spring of 1931, while sunspot relative numbers in general are falling off from maximum to the approaching minimum in the solar cycle.

It seems therefore as though solar radiation were quite independent of solar activity. A direct comparison between the march of ultra-violet solar radiation and the solar constant * * * reveals a tendency somewhat fatal to the theory that both quantities are correlated and have a common physical source. If the reality of a fluctuation in the total and the ultra-violet radiation should be proved, much further work will be needed to find the cause for the strange fact that solar radiation measured in the main spectrum, and solar radiation measured in the short wavelengths, manifest a quite different behaviour, and that the march of both quantities is obviously not related to the general variations of solar activity. We may also state that aurorae and terrestrial magnetism are the only phenomena which obviously vary in accordance with the solar activity.

During the polar year August, 1932, to August, 1933, inclusive, meteorologists and meteorological services of the world will unite in a study of meteorological conditions in both Arctic and Antarctic regions, with a view to determining their influence upon the weather in lower latitudes. The program includes solar radiation measurements, but hardly of the character that are required to measure solar variability, except as it is reflected in magnetic measurements. The work should, however, shed light upon the origin and movements of the great surges of air that move at frequent intervals from polar to equatorial regions, and vice versa, and which are the cause of the frequent and marked weather changes in middle latitudes.

SOUNDING-BALLOON OBSERVATIONS MADE AT ROYAL CENTER, IND., DURING THE INTERNATIONAL MONTH, FEBRUARY, 1931

By LEROY T. SAMUELS

[Weather Bureau, Washington, D. C., August, 1931]

In cooperation with the International Commission for the Exploration of the Upper Atmosphere, the Weather Bureau conducted a series of sounding-balloon observations at the Royal Center,[1] Ind., aerological station during the international month, February, 1931. The same general program was followed as during the international months of previous years since 1926, and the reader is referred to references (1), (2), (3), and (4) for further details regarding this.

In several respects, however, new features were introduced during this series which proved to be of material advantage. These were: (1) An increase in the length of the cord between the balloon and the meteorograph to approximately 80 feet. This eliminated the vibration of the instrument and resulted in very satisfactory traces on the record sheet; (2) the use of a device which permitted the balloon, after bursting, to become detached from the meteorograph and parachute. This resulted in a more satisfactory rate of descent of the instrument. A detailed description of this detaching device may be found in reference (5); (3) the difficulty of launching a balloon with the meteorograph tied a considerable distance below it during a moderate or strong wind was overcome by launching it from an automobile while driving with the wind.

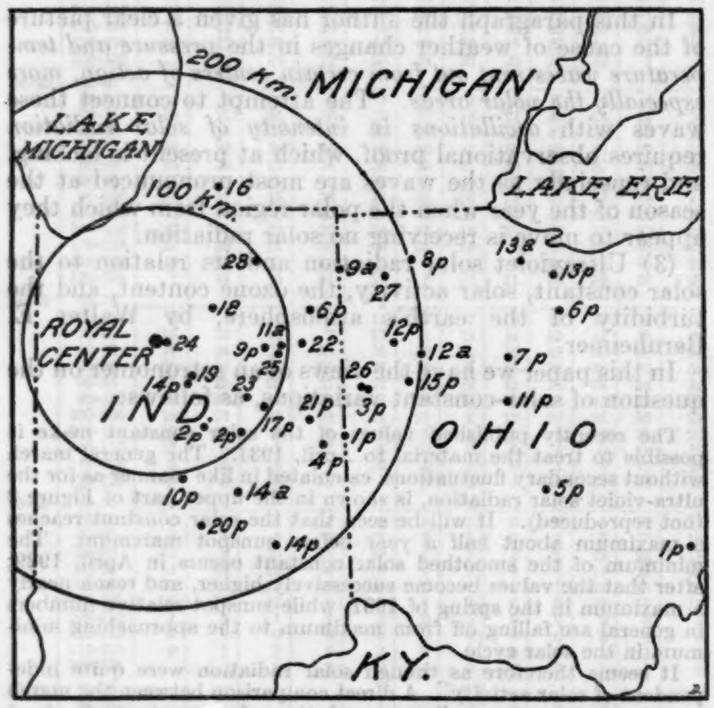


FIGURE 1.—Landing places (with dates of ascent) of meteorographs released from Royal Center, Ind., during February, 1931

There were 38 balloons released during the month and in 7 cases two meteorographs were attached to the same balloon in order to determine the agreement between the individual records. In only 2 of the 7 cases (seventh and eleventh) was it possible to make detailed comparisons. In these the agreement was found to be excellent, the temperature at all points in the records agreeing to within 2° C. at any particular altitude. In the record of the seventh the maximum altitudes as determined separately by the two instruments were 16,963 and 17,043 meters, respectively, or a variation of only one-half per cent. Further details regarding this comparison may be found in reference (6).

In four cases additional balloons were released shortly after sunset to determine the effect of insolation upon the meteorograph. The plan was to compare the temperature record with that obtained in the regular observation made about one hour before sunset. In only one case (the flights of the second) was a comparison possible. The temperatures in this case agreed to within 1° C. at any particular altitude within the troposphere, but the record of the second instrument indicated a temperature of about 5° C. lower in the stratosphere. Whether this was a result of insolation or instrumental error is uncertain and additional tests of this kind are therefore desirable. Further details regarding this comparison may be found in reference (6).

Out of a total of 45 meteorographs released, 42 (93 per cent) were returned.

Table 1 contains a summary of the individual observations. The landing places are shown in Figure 1.

The average altitude reached during the series was 13,665 meters, and the extreme height reached was 27,683 meters on the 15th. The next highest altitude reached was 18,074 meters on the 24th.

Following are some of the significant features of the tropopause obtained for the more recent monthly series of sounding-balloon observations made in this country.

Place	Date	Mean height of tropopause	Mean temperature of tropopause	Maximum height of tropopause observed	Minimum height of tropopause observed	Range in height of tropopause observed
		Meters, M. S. L.	*°C.*	*Meters, M. S. L.*	*Meters, M. S. L.*	*Meters*
Royal Center, Ind.	February, 1931	10,307	−61.1	11,550	8,344	3,206
Royal Center, Ind. (4)	September, 1930	12,914	−59.3	14,615	10,898	3,717
Broken Arrow, Okla. (3)	December, 1929	10,083	−54.0	12,212	7,728	4,484
Groesbeck, Tex. (2)	October, 1927	14,823	−65.5	17,467	11,695	5,772
Royal Center, Ind. (1)	May, 1926	12,011	−58.4	15,840	8,878	6,962

The lower average height of the tropopause at Royal Center in February than in September and May is to be expected; likewise, the correspondingly lower temperature for a winter month.

The mean temperature curve for the month, together with the altitude and temperature of the tropopause for the individual observations and the corresponding dates, is shown in Figure 2. The portion of the curve above 18 kilometers must be accepted with reservation since it is based on only a single observation.

The maximum monthly average lapse rate and the altitude interval at which it occurred is given below for the various monthly series referred to in the preceding table.

Place	Date	Maximum average lapse rate	Altitude interval of occurrence
		°C./100 m	*Km*
Royal Center, Ind.	February, 1931	0.84	7–8
Royal Center, Ind. (4)	September, 1930	.77	9–10
Broken Arrow, Okla. (3)	December, 1929	.77	6–7
Groesbeck, Tex. (2)	October, 1927	.79	7–8
Royal Center, Ind. (1)	May, 1926	.71	7–8

[1] Lat. 40° 53′ N., long. 86° 29′ W.

It will be noted that the maximum average lapse rate for the present series was greater than that for the months of May and September at this station in previous series.

In Figure 3, are shown the individual temperature-altitude curves. The surface temperature is indicated at the bottom of each curve and the temperature at the maximum altitude at the top. The wind directions, whenever observed, are indicated for the standard levels adjacent to the corresponding curves. Conspicuous in these wind directions are those for the 24th, when an easterly component persisted throughout the troposphere. The winds in the stratosphere on this date were westerly. The continuation of easterly winds to such high elevations in the winter season at this latitude is observed only occasionally and was evidently the result of abnormally high temperatures over the Great Lakes which resulted in a reversal of the normal latitudinal temperature gradient.

In Figure 4 are shown the free-air isotherms for the month with dates indicated across the top.

The relatively small fluctuation in the height of the tropopause throughout the month is noticeable.

Figure 5 shows the mean wind velocity and direction curves for the month. The increase indicated in the average velocity after the stratosphere is reached is doubtful, since the curve is based on less than five observations at and above 12 kilometers. The mean direction is very constant.

In Table 2 are given the tabulated data of the individual ascents. The elevation of the tropopause has been indicated in each case where it was observed. The relative humidities as recorded have been included, but the uncertainty of hair hygrographs at temperatures below −15° C. must be kept in mind.

References to sounding-balloon observations made in this country previous to 1926 may be found listed on page 302 of reference (1).

REFERENCES

(1) Monthly Weather Review, July, 1927.
(2) Monthly Weather Review, June, 1929.
(3) Monthly Weather Review, August, 1931.
(4) Monthly Weather Review, November, 1931.
(5) Monthly Weather Review, February, 1931.
(6) Monthly Weather Review, June, 1931.

TABLE 1.—*Summary of sounding-balloon ascents made at Royal Center, Ind., during February, 1931*

Date	Time of release, 90th mer.	Stratosphere		Maximum height reached, M. S. L.	Minimum temperature recorded	Balloon followed with		Meteorograph found	
		Height of base, M.S.L.	Temperature at base			2 theodolites	1 theodolite	Distance from station	Direction from station
		Meters	*°C.*	*Meters*	*°C.*	*Min. obsrd.*	*Min. obsrd.*	*Km.*	
1	4:08 p. m.	10,625	−61.4	14,090	−61.4	6	7	456	ESE.
2	3:55 p. m.	10,021	−61.7	11,382	−61.7	3	--------	73	SSE.
2	5:18 p. m.	11,014	−65.1	12,847	−65.1	0	0	94	SE.
3	4:12 p. m.	--------	--------	[1] 11,589	--------	51	--------	(²)	
3	5:46 p. m.	9,787	−60.1	13,158	−61.6	0	0	163	ESE.
4	4:02 p. m.	10,121	−62.0	[1] 13,706	−62.6	71	73	146	ESE.
5	4:18 p. m.	--------	--------	9,899	−54.7	7	9	313	ESE.
6	4:06 p. m.	--------	--------	3,534	−6.6	13	15	307	E.
6	4:40 p. m.	--------	--------	10,078	−63.9	0	0	118	E.
7	4:11 p. m.	11,288	−64.5	17,043	−64.7	0	0	266	E.
8	3:58 p. m.	11,024	−66.9	12,160	−67.1	5	--------	202	ENE.
9	7:06 a. m.	10,914	−58.0	13,831	−58.0	31	36	153	ENE.
9	4:01 p. m.	(³)	--------	[1] 2,123	--------	7	7¾	80	E.
10	7:04 a. m.	--------	--------	[1] 11,952	--------	40	--------	(¹)	
10	4:10 p. m.	9,333	−63.3	9,522	−63.3	26	34	102	S.
11	7:29 a. m.	--------	--------	7,171	−36.5	1	8	94	E.
11	4:18 p. m.	9,404	−58.5	14,515	−59.9	0	5¼	270	ESE.
12	7:44 a. m.	10,378	−62.3	16,799	−62.3	4	--------	200	E.
12	4:01 p. m.	9,715	−63.6	11,970	−63.6	9	--------	180	E.
13	7:26 a. m.	10,236	−61.1	10,929	−61.1	0	1½	283	E.
14	7:17 a. m.	8,344	−47.6	10,373	−47.6	3½	--------	127	SSE.
14	4:10 p. m.	9,170	−57.4	12,577	−57.4	23	39	175	SSE.
15	4:30 p. m.	10,338	−56.6	27,683	−64.4	7	--------	193	E.

[1] Obtained from 2-theodolite observations. [2] Not found. [3] Poor record.

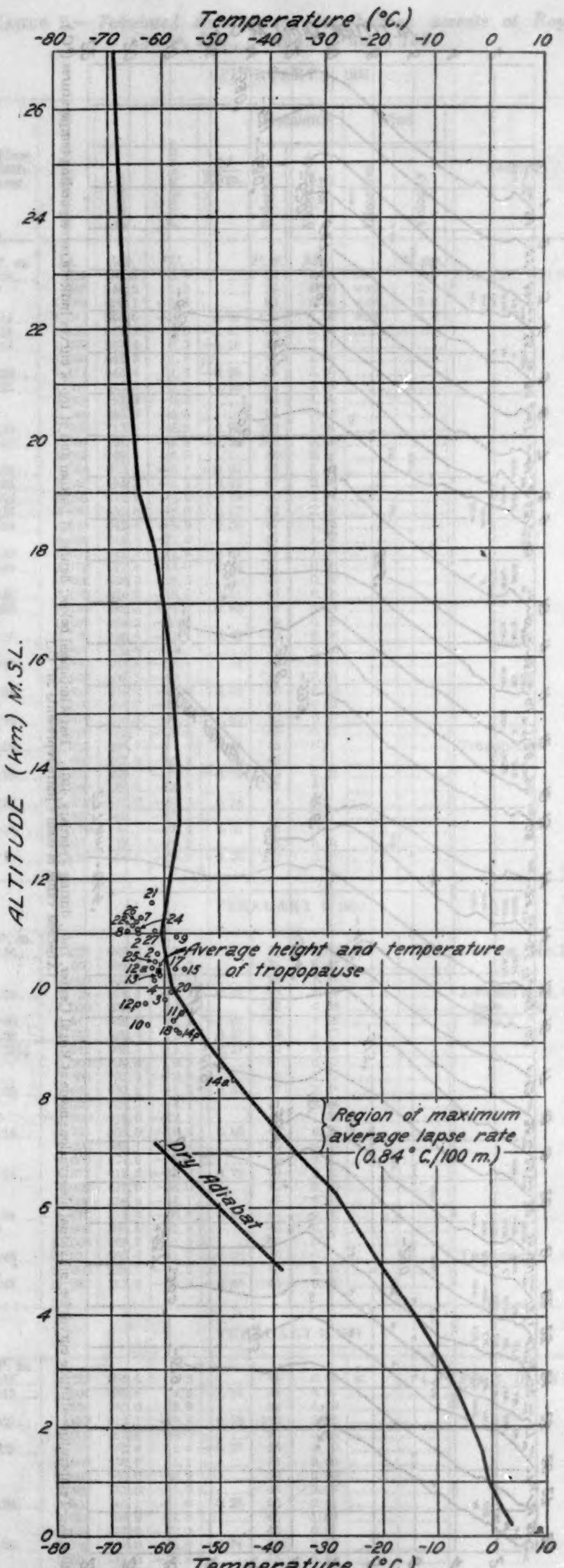


FIGURE 2.—Mean temperature (°C) for February, 1931, Royal Center, Ind. Circles indicate height and temperature of tropopause with corresponding dates

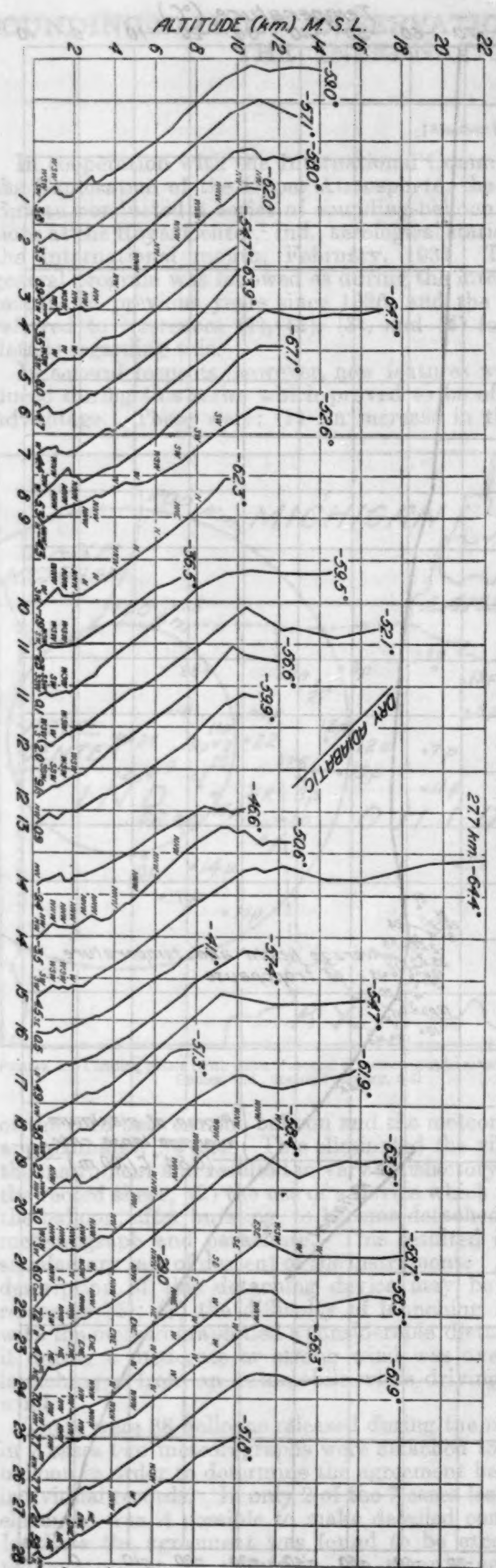


FIGURE 3.—Temperature-altitude curves for individual observations made at Royal Center, Ind., during February, 1931. Dates indicated below; figures at bottom and at top of curves indicate corresponding temperatures (°C.). (Abscissa value of each square represents 20° C.)

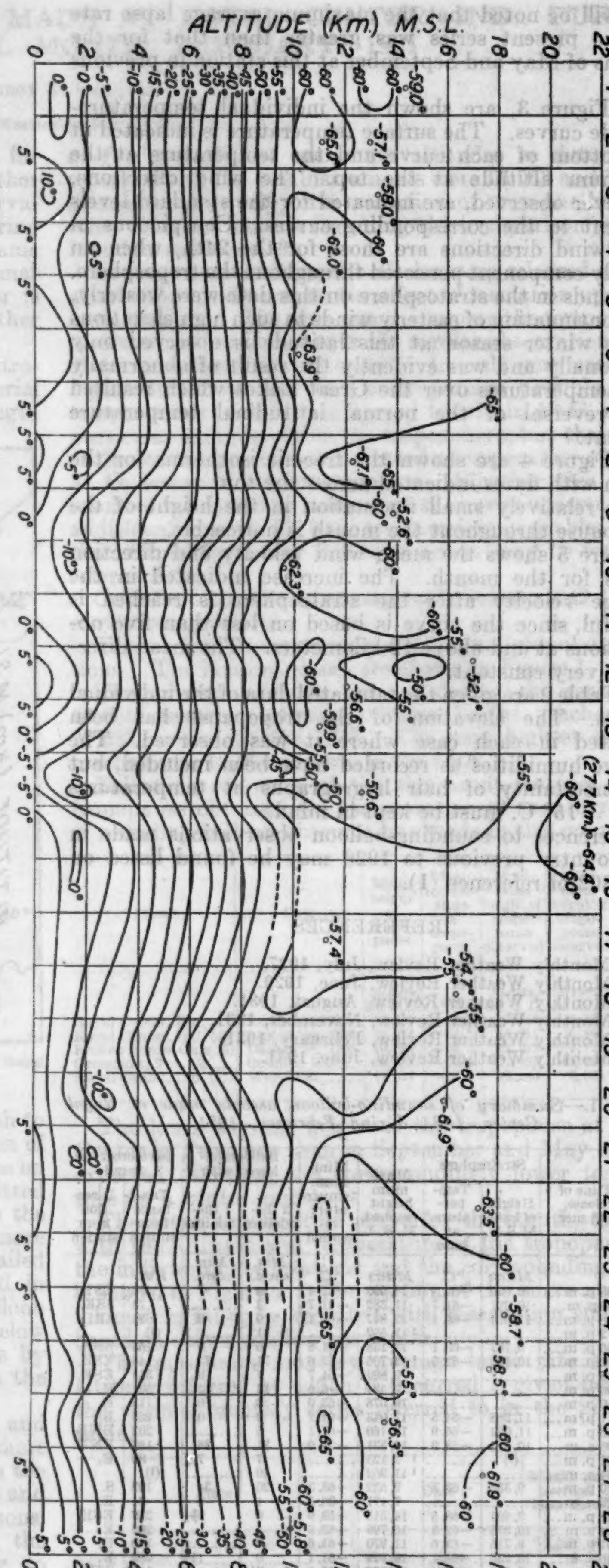


FIGURE 4.—Free-air isotherms (°C.) observed at Royal Center, Ind. during February, 1931. (Broken lines drawn between dates with missing data)

TABLE 1.—*Summary of sounding-balloon ascents made at Royal Center, Ind., during February, 1931*—Continued

Date	Time of release 90th mer.	Stratosphere: Height of base, M.S.L.	Stratosphere: Temperature at base	Maximum height reached, M.S.L.	Minimum temperature recorded	Balloon followed with: 2 theodolites	Balloon followed with: 1 theodolite	Meteorograph found: Distance from station	Meteorograph found: Direction from station
		Meters	*°C.*	*Meters*	*°C.*	*Min. obsrd.*	*Min. obsrd.*	*Km.*	
16	4:07 p. m.	-------	-------	8,333	−41.1	0	0	126	NNE.
17	4:06 p. m.	10,353	−58.2	11,189	−58.2	0	0	95	ESE.
18	4:10 p. m.	9,205	−57.8	16,172	−57.8	0	0	50	ENE.
19	4:15 p. m.	-------	-------	7,690	−51.3	1½	-------	40	SE.
20	4:17 p. m.	9,930	−58.9	15,749	−61.9	2¾	-------	140	SSE.
21	4:12 p. m.	11,550	−62.5	[1] 17,321	−62.5	68	83	130	ESE.
22	4:13 p. m.	11,149	−66.0	17,034	−66.0	13¾	-------	110	E.
23	4:10 p. m.	-------	-------	[1] 15,518	−29.0	65	66	80	ESE.
24	4:11 p. m.	11,067	−65.2	18,074	−65.2	77	-------	9	E.
25	4:12 p. m.	10,474	−61.8	17,483	−61.8	0	40	95	E.
26	4:11 p. m.	11,211	−65.5	13,420	−65.5	45	48	158	ESE.
27	8:24 p. m.	11,036	−61.9	17,263	−61.9	0	0	178	ENE.
28	4:19 p. m.	-------	-------	10,047	−61.8	29	-------	96	NE.

[1] Obtained from 2-theodolite observations.

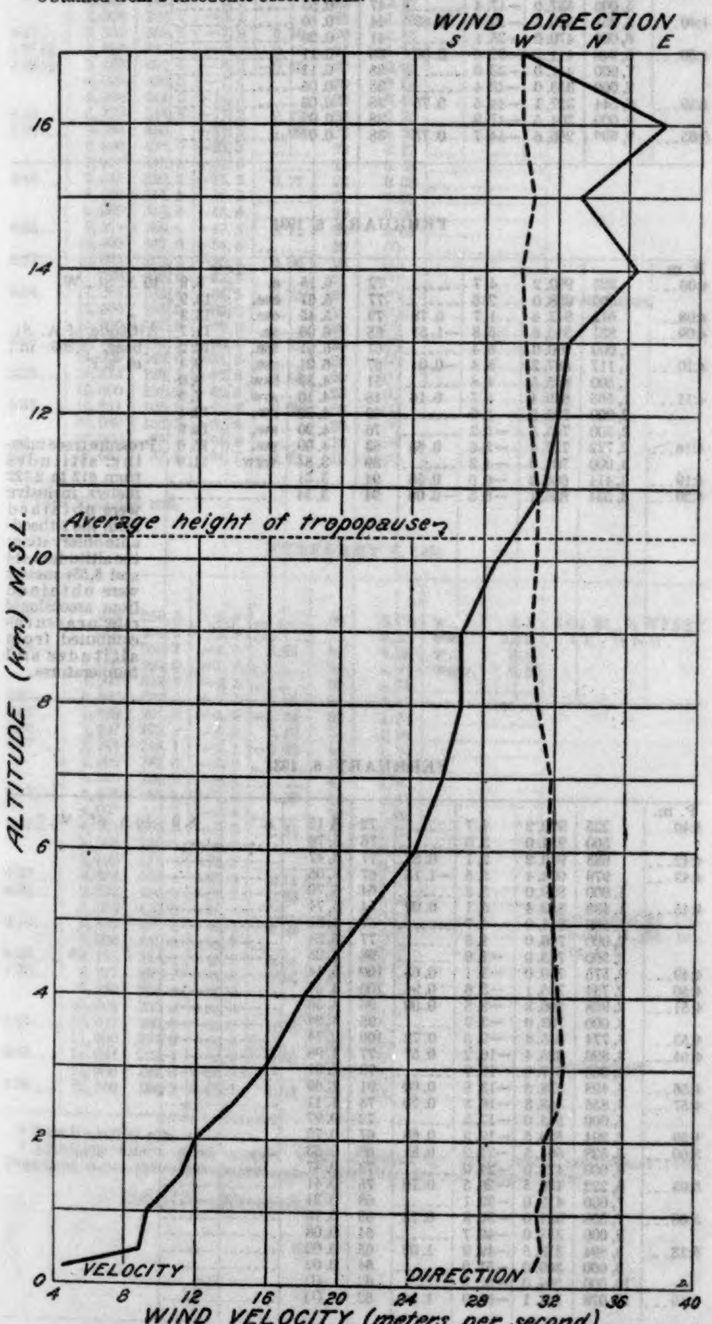


FIGURE 5.—Mean wind velocity (m. p. s.) and direction curves for February, 1931, Royal Center, Ind.

TABLE 2.—*Tabulated data of sounding-balloon ascents at Royal Center, Ind., during February, 1931*

FEBRUARY 1, 1931

Time 90th mer.	Altitude, M. S. L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
P. m.	M.	Mb.	°C.		P. ct.	Mb.		M.p.s.	
4:08	225	990.5	3.8	-------	60	4.81	sw.	5.8	8 St. Cu., WNW ?
	500	956.2	1.3	-------	73	4.90	wsw.	12.1	
	1,000	904.1	−3.3	-------	98	4.56	wsw.	13.0	
4:14	1,041	894.6	−3.7	0.92	100	4.50	wsw.	13.2	
4:16	1,197	877.1	0.0	−2.37	53	3.24	-------	-------	
4:18	1,379	857.4	0.3	−0.16	44	2.75	-------	-------	
	1,500	844.5	1.5	-------	57	3.88	-------	-------	
4:20	1,511	843.4	1.6	−0.98	58	3.98	-------	-------	
4:22	1,816	812.1	1.1	0.16	82	5.42	-------	-------	
	2,000	793.9	−0.7	-------	85	4.90	-------	-------	
	2,500	745.3	−5.5	-------	94	3.64	-------	-------	
4:29	2,835	713.9	−8.8	0.97	100	2.91	-------	-------	
4:30	2,891	708.7	−6.9	−3.39	100	3.43	-------	-------	
	3,000	699.4	−6.0	-------	86	3.18	-------	-------	
4:32	3,034	695.9	−5.7	−0.84	82	3.12	-------	-------	
4:33	3,153	685.3	−6.2	0.42	67	2.44	-------	-------	
4:35	3,296	672.9	−6.9	0.49	80	2.74	-------	-------	
4:37	3,544	651.8	−8.8	0.77	82	2.39	-------	-------	
4:39	3,656	642.4	−8.9	0.09	67	1.93	-------	-------	
	4,000	614.3	−11.2	-------	67	1.57	-------	-------	
4:43	4,012	613.5	−11.3	0.67	67	1.56	-------	-------	
4:49	4,470	577.8	−14.0	0.59	51	0.93	-------	-------	
	5,000	538.1	−18.3	-------	48	0.59	-------	-------	
4:56	5,059	534.3	−18.8	0.81	48	0.56	-------	-------	
5:05	5,734	487.5	−24.4	0.83	48	0.33	-------	-------	
	6,000	469.2	−26.2	-------	49	0.28	-------	-------	
5:15	6,730	424.4	−31.1	0.67	52	0.18	-------	-------	
	7,000	409.6	−34.2	-------	51	0.12	-------	-------	
5:25	7,343	388.8	−38.1	1.14	50	0.08	-------	-------	
	8,000	354.8	−43.7	-------	50	0.04	-------	-------	
5:38	8,422	331.4	−47.3	0.85	50	0.03	-------	-------	
	9,000	303.7	−52.3	-------	50	0.01	-------	-------	
5:49	9,329	288.3	−55.2	0.87	50	0.01	-------	-------	
	10,000	259.7	−58.4	-------	49	0.01	-------	-------	
6:08	10,625	234.7	−61.4	0.48	48	(1)	-------	-------	Tropopause.
	11,000	221.3	−60.3	-------	46	(1)	-------	-------	
6:18	11,516	203.5	−58.8	−0.29	43	0.01	-------	-------	
	12,000	188.8	−59.5	-------	43	(1)	-------	-------	
6:37	12,569	171.2	−60.3	0.14	43	(1)	-------	-------	
	13,000	160.7	−60.3	-------	43	(1)	-------	-------	
6:56	13,479	148.7	−60.4	0.01	43	(1)	-------	-------	
	14,000	136.8	−59.2	-------	43	0.01	-------	-------	
7:12	14,090	134.9	−59.0	−0.23	43	0.01	-------	-------	

FEBRUARY 2, 1931

Time 90th mer.	Altitude, M. S. L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
P. m.									
3:55	225	996.4	6.9	-------	69	6.87	e.	4.5	9 St. Cu., NNE.
	500	958.5	4.3	-------	78	6.47	-------	-------	
	1,000	904.1	−0.5	-------	94	5.51	-------	-------	
3:59	1,129	891.1	−1.7	0.95	98	5.20	-------	-------	Altitude of St. Cu. base, 962 m., m. s. l.
	1,500	850.0	2.0	-------	59	4.16	-------	-------	
4:00	1,517	849.0	2.2	−1.01	57	4.08	-------	-------	
4:02	1,763	823.4	0.8	0.57	53	3.43	-------	-------	
4:02½	1,912	808.1	1.2	−0.27	52	3.46	-------	-------	
	2,000	799.4	0.9	-------	51	3.33	-------	-------	
	2,500	751.3	−0.8	-------	48	2.75	-------	-------	
4:05	2,651	737.2	−1.3	0.34	47	2.58	-------	-------	
	3,000	705.5	−4.1	-------	47	2.04	-------	-------	
	4,000	619.0	−12.1	-------	48	1.04	-------	-------	
4:15	4,798	558.0	−18.5	0.80	49	0.59	-------	-------	
	5,000	542.1	−20.1	-------	49	0.50	-------	-------	
	6,000	474.0	−28.0	-------	49	0.23	-------	-------	
4:24	6,877	419.5	−35.0	0.79	49	0.11	-------	-------	
	7,000	412.0	−36.0	-------	49	0.10	-------	-------	
	8,000	356.8	−44.1	-------	47	0.04	-------	-------	
4:34	8,810	316.0	−50.6	0.81	45	0.02	-------	-------	
	9,000	306.9	−52.3	-------	45	0.01	-------	-------	
	10,000	263.7	−61.5	-------	45	(1)	-------	-------	
4:43	10,021	262.4	−61.7	0.92	45	(1)	-------	-------	Tropopause.
	11,000	226.2	−58.2	-------	45	0.01	-------	-------	
4:48	11,382	212.6	−56.8	−0.46	45	0.01	-------	-------	

FEBRUARY 2, 1931

Time 90th mer.	Altitude, M. S. L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
P. m.									
5:18	225	996.5	3.5	-------	84	6.59	e.	4.0	Few A. St., N ?
5:19	304	986.8	4.3	−1.01	84	6.97	-------	-------	
	500	960.0	2.9	-------	89	6.69	-------	-------	
5:21	932	913.1	−0.3	0.73	100	5.96	-------	-------	
	1,000	905.0	0.0	-------	93	5.68	-------	-------	
5:23	1,389	862.4	1.4	−0.37	56	3.79	-------	-------	
	1,500	850.0	1.1	-------	55	3.64	-------	-------	
	2,000	800.0	−0.2	-------	50	3.00	-------	-------	
	2.500	751.0	−1.5	-------	45	2.43	-------	-------	
5:26	2,551	746.1	−1.6	0.26	45	2.41	-------	-------	
	3,000	706.0	−4.9	-------	45	1.83	-------	-------	
	4,000	617.0	−12.2	-------	45	0.97	-------	-------	
5:36	4,780	559.0	−18.0	0.74	45	0.57	-------	-------	
	5,000	543.0	−19.8	-------	45	0.48	-------	-------	
	6,000	474.0	−28.1	-------	44	0.21	-------	-------	

[1] Less than 0.01 mb.

TABLE 2.—*Tabulated data of sounding-balloon ascents at Royal Center, Ind., during February, 1931*—Continued

FEBRUARY 2, 1931—Continued

Time 90th mer.	Altitude, M. S. L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
P. m.	M.	Mb.	°C.		%	Mb.		M.p.s.	
5:45	6,621	434.5	−33.2	0.83	44	0.12			
	7,000	414.0	−36.4		44	0.08			
	8,000	357.0	−45.0		43	0.03			
5:54	8,304	340.5	−47.6	0.86	43	0.02			
	9,000	307.0	−53.2		42	0.01			
6:03	9,716	274.7	−59.0	0.81	40	(1)			
	10,000	263.5	−60.3		40	(1)			
	11,000	224.5	−65.0		40	(1)			
6:09	11,014	224.1	−65.1	0.47	40	(1)			Tropopause.
	12,000	191.0	−60.8		42	(1)			
6:20	12,847	167.3	−57.1	−0.44	43	0.01			

[1] Less than 0.01 mb.

FEBRUARY 3, 1931

Time 90th mer.	Altitude, M. S. L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
P. m.									
5:46	225	988.2	8.9		62	7.07	sw.	3.1	1 Ci. St., NW.; 10 Light Haze.
5:47	367	969.8	12.1	−2.25	53	7.48			
	500	953.0	11.0		53	6.96			
	1,000	899.0	7.6		57	5.95			
5:50	1,275	869.5	5.5	0.73	58	5.24			
5:51	1,326	861.5	5.7	−0.39	56	5.13			
	1,500	843.0	4.6		56	4.75			
	2,000	794.0	0.8		56	3.62			
5:54	2,009	792.8	0.8	0.72	56	3.62			
5:56	2,193	773.3	0.8	0.00	46	2.98			
	2,500	743.0	−1.1		42	2.34			
	3,000	698.0	−4.4		37	1.57			
6:01	3,126	686.5	−5.3	0.65	35	1.38			
	4,000	614.0	−10.8		30	0.73			
6:07	4,213	597.3	−12.3	0.64	29	0.62			
6:08	4,473	574.2	−14.7	0.92	32	0.55			
6:11	4,962	538.6	−18.3	0.74	29	0.36			
	5,000	537.0	−18.7		29	0.34			
	6,000	466.5	−27.1		29	0.15			
6:18	6,655	425.4	−32.9	0.86	29	0.08			
	7,000	405.0	−35.9		29	0.06			
	8,000	349.5	−44.8		29	0.02			
6:25	8,206	338.8	−46.7	0.80	29	0.02			
	9,000	300.5	−53.3		29	0.01			
6:32	9,787	265.1	−60.1	0.85	29	(1)			Tropopause.
	10,000	257.0	−60.5		29	(1)			
6:37	10,577	234.4	−61.6	0.19	29	(1)			
6:38	10,812	225.3	−61.0	−0.26	29	(1)			
	11,000	219.0	−58.7		29	(1)			
6:40	11,154	214.0	−56.5	−1.32	29	(1)			
6:42	11,256	210.4	−56.3	−0.20	26	(1)			
6:45	11,735	195.0	−57.8	0.31	26	(1)			
	12,000	186.7	−57.0		26	(1)			
6:50	12,398	175.4	−55.9	−0.29	26	(1)			
	13,000	158.8	−57.4		26	(1)			
6:56	13,158	154.9	−58.0	0.28	26	(1)			

[1] Less than 0.01 mb.

FEBRUARY 4, 1931

Time 90th mer.	Altitude, M. S. L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
P. m.									
4:02	225	994.6	3.5		48	3.77	n.	1.8	1 Ci. St., WNW.
	500	959.0	0.9		50	3.26	nnw.	2.2	
	1,000	903.0	−3.7		53	2.38	nw.	2.4	
4:06	1,158	884.9	−5.2	0.93	54	2.14	nw.	2.3	
4:06½	1,272	872.2	−2.0	−2.81	44	2.28	nw.	2.4	
	1,500	847.0	−2.2		41	2.09	wnw.	3.8	
4:07	1,540	843.2	−2.2	0.07	40	2.04	wnw.	4.2	
	2,000	795.0	−4.1		38	1.65	nw.	7.6	
4:10	2,272	768.7	−5.2	0.41	37	1.47	nw.	8.9	
4:11	2,338	762.3	−5.2	0.00	35	1.39	nw.	9.4	
	2,500	746.0	−3.8		34	1.52	nw.	10.4	
4:11½	2,522	744.6	−3.6	−0.87	34	1.54	nw.	10.4	
4:14	2,943	705.8	−4.8	0.28	37	1.52	nw.	10.4	
	3,000	703.0	−4.9		36	1.47	nw.	10.4	
4:15	3,139	688.4	−5.0	0.10	35	1.41	nw.	10.8	
	4,000	615.0	−11.5		35	0.80	nw.	12.3	
4:23	4,904	547.0	−18.3	0.75	35	0.43	nw.	14.4	
	5,000	540.0	−19.0		35	0.40	wnw.	14.5	
	6,000	472.0	−26.5		33	0.18	nw.	18.7	
4:30	6,473	441.8	−30.0	0.75	32	0.12	nw.	20.4	
	7,000	411.0	−35.1		32	0.07	wnw.	20.0	
4:33	7,088	404.8	−35.9	0.96	32	0.06	wnw.	20.0	
	8,000	355.0	−44.5		32	0.02	wnw.	20.5	
4:41	8,484	330.3	−49.0	0.94	32	0.01	wnw.	21.5	
	9,000	305.0	−53.4		32	0.01	wnw.	22.6	
4:45	9,079	301.7	−54.1	0.86	32	0.01	wnw.	24.0	
4:45½	9,296	292.2	−54.9	0.37	32	0.01	wnw.	25.2	
4:47	9,570	279.7	−57.5	0.95	32	(1)	nw.	25.9	
	10,000	262.0	−61.0		32	(1)	nw.	25.6	
4:50	10,121	256.5	−62.0	0.82	32	(1)	nw.	25.2	Tropopause.
4:52	10,521	240.6	−62.6	0.15	32	(1)	nw.	22.8	
	11,000	223.0	−62.1		32	(1)	nw.	24.0	
4:55	11,055	221.7	−62.0	−0.11	32	(1)	nw.	25.0	
	12,000						nw.	27.2	
	13,000						wnw.	26.8	
5:08	13,706						wnw.	28.0	

[1] Less than 0.01 mb.

TABLE 2.—*Tabulated data of sounding-balloon ascents at Royal Center, Ind., during February, 1931*—Continued

FEBRUARY 5, 1931

Time 90th mer.	Altitude, M. S. L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
P. m.	M.	Mb.	°C.		%	Mb.		M.p.s.	
4:18	225	985.6	8.0		54	5.79	sw.	3.1	1 Ci. Cu., NW., 4 A. Cu., NW., 3 St. Cu., W.
	500	955.0	5.7		56	5.13	sw.	10.7	
	1,000	897.5	1.4		59	3.99	w.	12.1	
4:21	1,217	872.5	−0.4	0.85	61	3.61	w.	12.6	
	1,500	841.0	−0.4		56	3.31	w.	15.8	
	2,000	791.0	−0.4		48	2.84	w.	18.6	
4:26	2,232	768.5	−0.4	0.00	44	2.60			
	2,500	742.0	−2.8		48	2.33			
	3,000	697.5	−7.3		56	1.85			
4:31	3,351	666.6	−10.5	0.90	62	1.56			
	4,000	613.5	−11.6		57	1.29			
4:34	4,202	596.5	−11.9	0.16	56	1.24			
	5,000	537.0	−17.4		47	0.63			
4:40	5,251	519.5	−19.1	0.69	44	0.50			
	6,000	470.0	−25.1		41	0.26			
4:50	6,948	411.6	−32.6	0.80	38	0.11			
	7,000	411.0	−33.0		38	0.11			
	8,000	353.0	−40.4		38	0.05			
4:59	8,544	327.1	−44.5	0.75	38	0.03			
	9,000	304.5	−47.9		38	0.02			
5:05	9,899	266.6	−54.7	0.75	38	0.01			

FEBRUARY 6, 1931

Time 90th mer.	Altitude, M. S. L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
P. m.									
4:06	225	990.2	4.7		72	6.15	e.	8.9	10 A. St., W.
	500	958.0	2.6		77	5.67	ese.	13.9	
4:08	612	942.8	1.7	0.78	79	5.45	ese.	13.3	
4:09	851	916.6	5.3	−1.51	68	6.06	se.	11.7	Altitude of A. St. base, 3,305 m., m. s. l.
	1,000	900.0	5.4		67	6.01	sse.	10.2	
4:10	1,117	887.2	5.4	−0.04	67	6.01	sse.	9.4	
	1,500	845.5	4.8		51	4.39	ssw.	8.0	
4:11	1,568	839.4	4.7	0.16	48	4.10	ssw.	7.9	
	2,000	795.5	1.9		60	4.20	sw.	10.1	
	2,500	745.5	−1.2		76	4.20	sw.	14.9	
4:16	2,722	727.4	−2.6	0.63	83	4.09	sw.	15.0	Pressure trace missing; altitudes from 612 to 2,722 meters inclusive were obtained from the 2-theodolite observation; the altitudes 3,414 and 3,534 meters were obtained from ascensional rate; pressures computed from altitudes and temperatures.
	3,000	701.0	−4.2		89	3.84	wsw.	11.9	
4:19	3,414	666.2	−6.6	0.58	94	3.31			
4:20	3,534	656.1	−6.5	−0.08	94	3.34			

FEBRUARY 6, 1931

Time 90th mer.	Altitude, M. S. L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
P. m.									
4:40	225	990.2	4.7		72	6.15	e.	8.9	10 A. St., W. ?
	500	954.0	3.0		76	5.76			
4:42	683	936.2	2.1	0.57	77	5.47			
4:43	979	903.4	5.5	−1.15	67	6.05			
	1,000	899.0	5.3		64	5.70			
4:45	1,438	852.4	5.1	0.09	54	4.74			
	1,500	844.0	4.7		57	4.87			
	2,000	796.0	1.5		77	5.24			
	2,500	745.0	−1.6		98	5.25			
4:49	2,575	740.0	−2.1	0.63	100	5.14			
4:50	2,734	726.1	−3.6	0.94	100	4.54			
4:51	2,958	706.3	−3.6	0.00	96	4.36			
	3,000	703.0	−3.9		96	4.24			
4:53	3,774	635.4	−9.5	0.72	100	2.74			
4:54	3,896	625.4	−10.2	0.57	77	1.98			
	4,000	617.0	−10.9		79	1.91			
4:56	4,498	578.5	−13.8	0.60	91	1.69			
4:57	4,855	553.3	−16.3	0.70	75	1.11			
	5,000	543.0	−17.3		72	0.97			
4:59	5,294	520.5	−19.3	0.68	67	0.75			
5:00	5,528	504.5	−21.2	0.81	68	0.63			
	6,000	474.0	−24.9		73	0.47			
5:03	6,222	459.5	−26.5	0.76	75	0.41			
	7,000	413.0	−32.1		68	0.21			
5:08	7,558	381.0	−36.3	0.73	65	0.13			
	8,000	358.0	−40.7		64	0.08			
5:13	8,894	313.5	−49.9	1.02	65	0.02			
	9,000	309.0	−51.0		64	0.02			
	10,000	264.0	−62.9		62	(1)			
5:19	10,078	261.1	−63.9	1.18	62	(1)			

[1] Less than 0.01 mb.

TABLE 2.—*Tabulated data of sounding-balloon ascents at Royal Center, Ind., during February, 1931*—Continued

FEBRUARY 7, 1931

Time 90th mer.	Altitude, M. S. L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
P. m.	M.	Mb.	°C.		%	Mb.		M.p.s.	
4:11	225	990.2	4.4		98	8.19	w.	3.6	10 St., W.
	500	955.0	2.8		98	7.32			
4:13	678	936.4	1.7	0.60	98	6.76			
4:13½	805	921.8	2.1	−0.31	96	6.82			
	1,000	899.5	1.2		95	6.33			
4:14	1,096	889.1	0.7	0.48	94	6.03			
4:15	1,214	876.3	3.6	−2.46	90	7.11			
4:16	1,345	862.2	3.8	−0.15	89	7.14			
	1,500	845.5	4.1		77	6.31			
4:17	1,622	833.4	4.4	−0.22	67	5.60			
	2,000	794.5	3.2		47	3.61			
4:20	2,079	787.6	2.9	0.33	43	3.23			
	2,500	745.0	0.0		42	2.57			
	3,000	703.0	−3.5		40	1.83			
4:27	3,500	658.8	−7.0	0.70	30	1.33			
4:27½	3,693	642.7	−7.2	0.10	34	1.14			
4:28½	3,836	631.4	−6.2	−0.70	27	0.98			
	4,000	620.0	−7.4		26	0.86			
	5,000	543.5	−14.5		23	0.40			
4:36	5,376	516.5	−17.2	0.77	22	0.30			
4:38	5,769	490.1	−21.5	1.09	22	0.20			
	6,000	476.0	−23.3		22	0.17			
	7,000	413.5	−31.0		22	0.06			
4:46	7,541	383.3	−35.2	0.77	22	0.05			
	8,000	357.5	−38.5		21	0.03			
	9,000	310.0	−45.6		20	0.01			
4:53	9,271	298.4	−47.5	0.71	20	0.01			
	10,000	267.0	−54.5		20	(1)			
4:57	10,091	263.6	−55.4	0.96	20	(1)			
	11,000	228.0	−62.3		21	(1)			
5:04	11,288	218.8	−64.5	0.76	21	(1)			Tropopause.
	12,000	195.0	−63.0		21	(1)			
	13,000	167.0	−60.8		20	(1)			
5:14	13,199	161.8	−60.4	−0.21	20	(1)			
	14,000	142.0	−61.6		20	(1)			
5:23	14,623	129.1	−62.6	0.15	20	(1)			
	15,000	121.0	−62.5		20	(1)			
5:33	15,911	105.2	−62.2	−0.03	20	(1)			
	16,000	103.5	−62.4		20	(1)			
	17,000	88.5	−64.6		18	(1)			
5:41	17,043	87.8	−64.7	0.22	18	(1)			

[1] Less than 0.01 mb.

FEBRUARY 8, 1931

Time 90th mer.	Altitude, M. S. L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
P. m.									
3:58	225	989.5	5.3		66	5.88	w.	4.5	5 Ci. St., NW? 5 St. Cu., WNW.
	500	954.0	2.8		72	5.38	nw.	12.2	
4:01	931	906.7	−1.1	0.91	82	4.58	w.	9.4	
	1,000	900.0	−1.7		83	4.41	wnw.	9.3	
	1,500	843.5	−6.1		92	3.38			
4:04	1,690	823.5	−7.7	0.87	96	3.07			
4:05	1,860	805.8	−4.9	−1.65	82	3.34			
4:06	1,997	792.4	−5.3	0.29	74	2.91			
4:07	2,341	758.1	−2.1	−0.93	46	2.36			
	2,500	743.0	−2.9		46	2.21			
	3,000	700.0	−5.4		47	1.83			
4:12	3,503	654.1	−7.9	0.50	48	1.51			
	4,000	613.5	−9.4		39	1.08			
4:15	4,054	609.3	−9.6	0.31	38	1.03			
	5,000	538.0	−16.3		38	0.56			
	6,000	471.5	−23.5		38	0.28			
4:23	6,018	469.5	−23.6	0.71	38	0.28			
4:24	6,222	456.2	−26.1	1.23	40	0.23			
	7,000	410.0	−33.1		49	0.14			Altitude of St. Cu. base, 1,333 m., m. s. l.
4:30	7,380	388.4	−36.5	0.90	53	0.10			
	8,000	355.0	−41.7		53	0.06			
4:33	[2] 8,195	344.6	−43.3	0.84	53	0.05			
4:36	8,917	309.8	−49.5	0.86	53	0.02			
	9,000	305.0	−50.3		53	0.02			
	10,000	262.0	−60.5		53	0.01			
4:41	10,047	260.8	−61.0	1.02	53	(1)			
	11,000	224.0	−66.7		53	(1)			
4:45	11,024	223.4	−66.9	0.60	53	(1)			Tropopause.
	12,000	191.0	−67.1		50	(1)			
4:50	12,160	186.2	−67.1	0.02	50	(1)			

[1] Less than 0.01 mb.
[2] Altitudes above 8,195 meters were obtained by using mean ascensional rate. Pressures above this altitude computed from altitudes and temperatures.

TABLE 2.—*Tabulated data of sounding-balloon ascents at Royal Center, Ind., during February, 1931*—Continued

FEBRUARY 9, 1931

Time 90th mer.	Altitude, M. S. L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
A. m.	M.	Mb.	°C.		%	Mb.		M.p.s.	
7:06	225	989.0	−4.3		93	3.98	n.	5.6	1 Ci. St., NW? few St. Cu. NW.
7:07	459	957.2	−2.1	−0.94	93	4.78	nnw.	7.2	
	500	954.0	−2.4		93	4.66	nnw.	7.8	
	1,000	896.0	−6.2		78	2.84	nnw.	7.6	
7:10	1,408	847.6	−9.3	0.76	67	1.86	nnw.	8.6	
	1,500	840.0	−9.6		66	1.79	nnw.	9.4	
	2,000	785.5	−10.9		56	1.36	nw.	12.8	
7:14	2,479	734.0	−12.2	0.27	47	1.01	wnw.	16.7	
	2,500	732.0	−12.6		47	0.98	wnw.	16.8	
7:16	2,909	686.7	−15.6	0.65	52	0.82	wnw.	18.1	
7:17	3,305	651.1	−15.0	−0.20	43	0.72	w.	18.4	
	4,000	603.0	−19.0		37	0.43	w.	21.7	
7:20	4,478	564.1	−21.7	0.57	33	0.29	w.	28.9	
7:22	4,998	528.6	−20.9	−0.15	32	0.31	w.	36.8	
7:24	5,549	489.1	−22.1	0.22	30	0.26	wsw.	40.5	
	6,000	462.0	−24.4		29	0.20	wsw.	41.3	
	7,000	402.0	−30.2		28	0.11	sw.	45.3	
7:29	7,227	388.5	−31.4	0.55	28	0.09	sw.	44.9	
	8,000	348.0	−37.8		28	0.05	sw.	47.8	
	9,000	302.0	−46.0		28	0.02	sw.	49.5	
7:35	9,119	296.4	−46.9	0.82	28	0.02	sw.	49.0	
	10,000	258.5	−52.4		28	0.01			
7:41	10,914	223.6	−58.0	0.58	28	(1)			
7:41	11,000	222.0	−57.9		28	(1)			
7:45	11,873	192.8	−56.4	−0.19	28	(1)			
	12,000	190.0	−56.1		28	0.01			
	13,000	162.0	−53.6		28	0.01			
7:51	13,352	153.5	−52.8	−0.24	28	0.01			
7:53	13,831	142.3	−52.6	−0.04	28	0.01			

[1] Less than 0.01 mb.

FEBRUARY 10, 1931

Time 90th mer.	Altitude, M. S. L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
P. m.									
4:10	225	997.0	−1.9		60	3.14	sw.	1.3	Few Ci., St., NW. 1 A. Cu., NW.
	500	900.0	−4.9		62	2.52	w.	2.1	
	1,000	901.0	−10.0		67	1.76	wnw.	3.4	
4:14	1,173	880.7	−11.7	1.03	68	1.53	wnw.	4.7	
4:15	1,418	856.4	−8.0	−1.51	58	1.81	nw.	5.0	
	1,500	844.0	−7.9		58	1.83	nnw.	4.5	
4:17	1,877	806.0	−7.7	0.07	52	1.66	nnw.	5.6	
	2,000	793.0	−8.0		52	1.62	nnw.	6.3	
4:18	2,234	769.4	−8.6	0.25	52	1.54	n.	7.3	
4:19	2,346	754.3	−8.6	0.00	53	1.57	n.	7.9	
	2,500	742.0	−9.6		51	1.38	n.	12.0	
	3,000	695.0	−12.8		53	1.08	n.	13.7	
	4,000	610.0	−19.3		54	0.60	nnw.	16.6	
4:25	4,182	595.6	−20.3	0.64	57	0.58	nnw.	16.5	
	5,000	533.0	−26.1		55	0.32	n.	20.2	
	6,000	462.2	−33.3		55	0.15	n.	21.1	
4:33	6,207	449.6	−34.7	0.71	55	0.13	n.	19.2	
	7,000	402.0	−40.8		55	0.06	nne.	26.2	
4:38	7,645	367.2	−45.9	0.78	55	0.04	n.	25.2	
	8,000	347.0	−49.4		55	0.02	n.	23.1	
4:44	8,823	309.2	−57.4	0.98	55	0.01			
	9,000	295.0	−59.6		55	0.01			
4:48	9,333	282.0	−63.3	1.18	55	(1)			Tropopause.
4:49	9,522	272.8	−63.3	0.00	55	(1)			

[1] Less than 0.01 mb.

FEBRUARY 11, 1931

Time 90th mer.	Altitude, M. S. L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
A. m.									
7:29	225	994.2	−2.3		75	3.80	sw.	6.7	8 A. St., W.; 1 A. Cu., W.
7:30	469	961.5	−4.4	0.86			wsw.	8.8	
	500	959.0	−4.3				wsw.	9.2	
	1,000	901.5	−3.4				wsw.	15.2	
7:33	1,056	893.5	−3.3	−0.19			wsw.	15.0	
	1,500	843.0	−3.7				wsw.	13.5	
7:37	1,979	793.5	−4.2	0.10					
	2,000	791.5	−4.3						
	2,500	741.0	−7.4						
	3,000	694.8	−10.6						
7:48	3,794	625.9	−15.6	0.63					
	4,000	611.0	−17.1						
	5,000	534.8	−24.4						
7:56	5,141	524.8	−25.5	0.73					
	6,000	466.0	−31.4						
8:04	6,008	465.6	−31.6	0.70					
8:13	6,661	423.4	−33.7	0.32					
	7,000	404.0	−35.5						
8:24	7,171	394.6	−36.5	0.55					

TABLE 2.—*Tabulated data of sounding-balloon ascents at Royal Center, Ind., during February, 1931*—Continued

FEBRUARY 11, 1931

Time 90th mer.	Altitude, M. S. L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
P. m.	M.	Mb.	°C.		%	Mb.		M.p.s.	
4:18	225	989.0	0.1		98	6.03	ssw.	5.8	10 St., W.
	500	954.0	−1.3		100	5.49	ssw.	23.8	
4:19	571	943.8	−1.7	0.52	100	5.31	ssw.	25.6	Snowing.
4:20	836	913.9	0.1	−0.68	98	6.03	ssw.	29.6	
	1,000	894.0	−0.3		100	5.96	sw.	30.7	
	1,500	840.0	−1.8		100	5.27	wsw.	42.2	
4:23	1,622	829.7	−2.1	0.28	100	5.14	wsw.	44.4	
4:24	1,754	815.2	−1.7	−0.30	100	5.31	wsw.	44.4	
	2,000	790.0	−3.6		100	4.54			
4:27	2,458	742.2	−7.3	0.80	100	3.31			
	2,500	735.9	−7.7		95	3.04			
4:29	2,978	697.2	−10.1	0.54	64	1.66			
	3,000	694.0	−10.4		65	1.64			
4:30	3,213	675.9	−13.6	1.49	70	1.33			
	4,000	606.0	−19.7		92	0.98			
4:34	4,172	591.7	−21.1	0.78	96	0.90			
	5,000	530.0	−27.1		94	0.49			
4:40	5,477	495.4	−30.7	0.74	92	0.33			
	6,000	461.0	−34.5		84	0.20			
4:48	6,956	401.7	−41.5	0.73	70	0.08			
	7,000	399.0	−42.2		70	0.07			
	8,000	343.0	−51.6		53	0.02			
4:55	8,027	342.0	−51.8	0.96	52	0.02			
	9,000	294.0	−56.6		50	0.01			
5:01	9,404	277.3	−58.5	0.49	50	0.01			Tropopause.
	10,000	252.0	−59.2		49	0.01			
5:08	10,659	226.5	−59.9	0.11	46	0.01			
	11,000	215.0	−59.6		46	0.01			
5:15	11,750	190.8	−58.7	−0.11	42	0.01			
	12,000	183.0	−58.6		42	0.01			
5:22	12,770	162.0	−58.5	−0.02	42	0.01			
	13,000	156.0	−58.4		40	0.01			
5:30	13,617	140.9	−58.3	−0.02	36	[1]			
	14,000	133.0	−58.6		34	[1]			
5:38	14,331	126.2	−58.9	0.08	32	[1]			
5:47	14,515	121.8	−59.5	0.33	30	[1]			

[1] Less than 0.01 mb.

FEBRUARY 12, 1931

Time 90th mer.	Altitude, M. S. L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
A. m.									
7:44	225	988.6	2.0		84	5.92	s.	3.6	2 Ci. St., W. ?.
7:45	386	969.0	1.6	0.25	85	5.83	sw.	7.0	7 St. Cu., WSW.
	500	956.0	1.9		85	5.95	wsw.	8.4	Altitude of St. Cu.,
7:46	556	948.9	2.0	−0.24	85	5.99	w.	8.8	base, 1,633 m.,
7:47	878	911.9	4.2	−0.68	72	5.94	w.	8.8	m. s. l.
	1,000	900.0	3.3		76	5.88	w.	7.6	
	1,500	843.0	−0.2		90	5.41	wsw.	7.0	
7:49	1,605	833.2	−0.9	0.70	93	5.27	wsw.	7.0	
7:50	1,819	811.1	−1.7	0.37	93	4.94			
	2,000	794.0	−3.0		95	4.53			
7:51	2,137	779.1	−3.9	0.69	96	4.24			
7:52	2,325	760.8	−3.7	−0.11	82	3.69			
	2,500	743.0	−4.9		72	2.93			
7:53	2,762	719.6	−6.6	0.66	57	2.01			
	3,000	700.0	−8.6		57	1.69			
7:56	3,494	654.6	−12.9	0.86	57	1.15			
7:58	3,847	624.8	−15.2	0.65	73	1.20			
	4,000	613.0	−16.3		73	1.08			
8:01	4,841	546.7	−22.5	0.74	70	0.57			
	5,000	537.0	−23.1		69	0.53			
8:03	5,278	515.0	−24.1	0.37	67	0.47			
8:05	5,758	482.0	−27.2	0.65	69	0.35			
	6,000	466.0	−28.9		66	0.28			
8:07	6,405	440.3	−31.7	0.69	62	0.20			
8:08	6,560	430.7	−33.3	1.03	52	0.14			
	7,000	405.0	−36.5		52	0.10			
	8,000	347.0	−43.6		54	0.05			
8:16	8,466	325.8	−47.0	0.72	54	0.03			
	9,000	300.0	−51.3		55	0.02			
	10,000	255.0	−59.3		56	0.01			
8:24	10,378	241.8	−62.3	0.80	56	[1]			Tropopause.
	11,000	219.0	−58.5		54	0.01			
	12,000	187.0	−52.3		51	0.02			
8:33	12,126	183.6	−51.5	−0.62	51	0.02			
8:35	12,621	170.1	−52.5	0.20	48	0.01			
	13,000	161.0	−51.7		47	0.02			
	14,000	137.0	−49.7		44	0.02			
8:48	14,770	122.5	−48.2	−0.20	42	0.02			
	15,000	118.0	−48.6		42	0.02			
	16,000	101.5	−50.6		41	0.02			
9:00	16,799	89.9	−52.1	0.19					

[1] Less than 0.01 mb.

FEBRUARY 12, 1931

Time 90th mer.	Altitude, M. S. L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
P. m.									
4:01	225	984.8	9.1		68	7.86	s.	4.5	8 Ci. St., W. 1 St.
	500	952.0	7.2		74	7.52	ssw.	11.7	Cu., SW.
	1,000	894.3	3.6		83	6.56	ssw.	16.2	
4:04	1,010	894.1	3.4	0.73	81	6.31	ssw.	16.2	Altitude of St. Cu.
4:05	1,183	875.0	3.6	−0.12	90	7.11	sw.	18.7	base, 2,120 m,
	1,500	840.0	1.6		93	6.38	wsw.	21.9	m. s. l.

TABLE 2.—*Tabulated data of sounding-balloon ascents at Royal Center, Ind., during February, 1931*—Continued

FEBRUARY 12, 1931—Continued

Time 90th mer.	Altitude, M. S. L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
P. m.	M.	Mb.	°C.		%	Mb.		M.p.s.	
4:09	1,897	800.6	−0.6	0.59	96	5.58	wsw.	19.5	
	2,000	790.0	−1.0		89	5.01	wsw.	20.8	
4:12	2,448	746.0	−2.6	0.36	52	2.56			
	2,500	740.0	−3.1		53	2.51			
4:14	2,887	703.9	−6.1	0.80	55	2.02			
	3,000	696.0	−7.1		57	1.92			
4:17	3,871	619.6	−15.1	0.92	66	1.09			
	4,000	610.0	−15.8		69	1.07			
4:21	4,651	559.7	−19.8	0.60	84	0.89			
	5,000	535.0	−22.2		84	0.71			
	6,000	465.0	−29.9		84	0.33			
4:28	6,283	446.8	−32.1	0.75	84	0.26			
	7,000	404.0	−37.2		83	0.15			
	8,000	348.0	−44.7		80	0.06			
4:36	8,303	333.0	−47.1	0.74	80	0.04			
	9,000	300.0	−55.0		79	0.02			
4:45	9,715	268.3	−63.6	1.17	78	0.01			Tropopause.
	10,000	256.0	−61.5		76	0.01			
4:48	10,282	244.5	−59.7	−0.69	74	0.01			
4:49	10,674	229.4	−59.3	−0.10	72	0.01			
4:50	10,996	217.8	−58.1	−0.37	68	0.01			
4:55	11,970	186.8	−56.6	−0.15	67	0.01			

FEBRUARY 13, 1931

Time 90th mer.	Altitude, M. S. L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
A. m.									
7:26	225	985.4	0.9		90	5.87	nw.	3.1	10 St., NNW.
	500	953.0	−1.2		95	5.25			
7:28	801	918.2	−3.4	0.75	100	4.61			
	1,000	892.0	−2.2		86	4.39			
7:30	1,239	868.8	−1.1	−0.52	66	3.68			Altitude of St.,
	1,500	837.0	−3.5		74	3.39			base, 631 m.,
7:31½	1,571	829.7	−4.4	0.99	76	3.22			m. s. l.
7:32	1,683	820.3	−4.4	0.00	81	3.43			
7:33½	2,004	785.9	−4.9	0.16	92	3.74			
7:34	2,137	771.6	−4.6	−0.23	96	4.00			
	2,500	736.0	−6.6		98	3.45			
7:37	2,836	706.8	−8.3		100	3.04			
	3,000	691.0	−9.6		100	2.71			
7:39	3,463	650.4	−12.6	0.60	100	2.08			
7:40	3,718	629.0	−12.9	0.12	96	1.94			
	4,000	607.0	−14.5		96	1.68			
	5,000	534.0	−20.6		96	0.95			
7:46	5,442	501.0	−23.3	0.60	96	0.73			
	6,000	465.0	−27.0		93	0.49			
	7,000	405.0	−34.0		86	0.22			
7:55	7,548	373.4	−37.9	0.69	82	0.13			
	8,000	350.0	−42.6		81	0.08			
8:01	8,476	325.8	−48.0	1.09	80	0.04			
	9,000	302.0	−53.0		81	0.02			
8:05	9,313	286.5	−56.0	0.96	81	0.02			
8:06	9,563	275.0	−56.8	0.32	81	0.01			
	10,000	257.0	−59.6		80	0.01			
8:08	10,236	247.3	−61.1	0.64	80	0.01			Tropopause.
8:11	10,929	221.5	−59.9	−0.17	76	0.01			

FEBRUARY 14, 1931

Time 90th mer.	Altitude, M. S. L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
A. m.									
7:17	225	1,001.3	−9.4		84	2.32	nw.	5.4	10 St., NW.
	500	968.0	−11.8		85	1.90			
7:18	510	967.0	−11.8	0.84	86	1.92			Altitude of St. base
7:19	836	924.8	−12.6	0.25	93	1.93			1,319 m., m. s. l.
	1,000	905.0	−13.8		95	1.77			
7:21	1,408	856.2	−17.0	0.77	98	1.36			
7:21½	1,499	846.2	−12.6	−4.84	94	1.96			
7:22	1,591	836.2	−11.4	−1.30	84	1.94			
7:23	1,856	810.0	−11.4	0.00	70	1.62			
	2,000	794.0	−12.6		63	1.31			
7:25	2,203	771.5	−13.8	0.69	57	1.06			
7:26	2,499	740.8	−14.0	0.07	48	0.88			
	3,000	696.0	−16.1		46	0.69			
7:31	3,458	652.9	−18.2	0.44	44	0.55			
	4,000	609.0	−21.1		42	0.39			
	5,000	532.0	−26.7		40	0.22			
7:39	5,080	525.2	−27.1	0.55	40	0.21			
7:42	5,906	468.9	−33.1	0.73	40	0.11			
	6,000	463.0	−33.8		40	0.10			
	7,000	401.0	−39.4		40	0.06			
7:48	7,222	389.2	−40.6	0.57	41	0.05			
	8,000	347.0	−45.2		41	0.03			
7:53	8,344	329.4	−47.6	0.62	41	0.02			Tropopause.
	9,000	298.0	−45.9		40	0.03			
7:55	9,027	296.7	−45.8	−0.26	40	0.03			
7:56	9,313	284.7	−46.2	0.14	41	0.02			
7:58	9,751	265.6	−44.2	−0.46	40	0.03			
7:59	9,965	257.2	−45.6	0.65	40	0.03			
	10,000	256.9	−45.7		40	0.03			
8:00	10,373	242.6	−46.6	0.24	40	0.02			

TABLE 2.—*Tabulated data of sounding-balloon ascents at Royal Center, Ind., during February, 1931*—Continued

FEBRUARY 14, 1931

Time 90th mer.	Altitude, M. S. L.	Pressure	Temperature	$\frac{\Delta t}{100 m.}$	Humidity		Wind		Remarks
					Relative	Vapor pressure	Direction	Velocity	
P. m.	M.	Mb.	°C.		%	Mb.		M.p.s.	
4:10	225	1,001.5	−3.5	-------	67	3.07	nw.	3.6	Few St. Cu. WNW.
	500	970.0	−6.0	-------	70	2.59	nw.	3.6	
4:13	959	911.6	−10.8	0.99	78	1.90	wnw.	5.6	
	1,000	907.0	−10.5	-------	75	1.88	wnw.	5.8	
4:14	1,265	878.3	−9.6	−0.39	60	1.63	nnw.	7.4	
	1,500	849.0	−9.4	-------	56	1.55	nnw.	9.6	
4:16	1,693	828.8	−9.4	−0.05	54	1.49	nnw.	10.5	
	2,000	799.0	−9.0	-------	56	1.60	nnw.	13.0	
4:17	2,030	793.0	−9.0	−0.12	55	1.57	nnw.	13.2	
	2,500	745.0	−12.8	-------	56	1.14	nnw.	16.0	
4:23	2,856	710.8	−15.2	0.75	56	0.92	n.	17.3	
	3,000	700.0	−14.2	-------	55	0.99	nnw.	18.3	
4:25	3,325	670.1	−12.6	−0.55	55	1.14	nnw.	20.4	
4:28	3,692	637.7	−13.6	0.27	54	1.03	nnw.	22.0	
	4,000	613.0	−16.0	-------	52	0.79	nnw.	24.7	
4:33	4,590	567.1	−20.9	0.81	51	0.49	nnw.	22.4	
4:34	4,692	559.9	−20.9	0.00	50	0.48	nnw.	24.8	
	5,000	537.0	−23.5	-------	50	0.37	nnw.	23.7	
	6,000	467.0	−32.3	-------	48	0.14	nnw.	26.0	
4:43	6,018	465.3	−32.6	0.88	48	0.14	nnw.	26.0	
	7,000	406.0	−41.6	-------	53	0.06	nnw.	30.0	
4:50	7,415	381.2	−45.5	0.92	55	0.04	nnw.	40.0	
4:52	7,854	356.3	−49.0	0.80	55	0.02	-------	-------	
	8,000	348.0	−49.8	-------	55	0.02	-------	-------	
	9,000	299.0	−56.2	-------	57	0.01	-------	-------	
4:57	9,170	290.7	−57.4	0.64	56	0.01	-------	-------	Tropopause.
4:59	9,537	274.0	−57.4	0.00	55	0.01	-------	-------	
5:00	9,945	256.7	−55.0	−0.59	54	0.01	-------	-------	
	10,000	254.5	−55.0	-------	53	0.01	-------	-------	
5:02	10,333	242.3	−55.8	0.21	54	0.01	-------	-------	
	11,000	218.0	−50.8	-------	55	0.02	-------	-------	
5:05	11,210	211.5	−49.2	−0.75	54	0.02	-------	-------	
5:06	11,475	202.6	−50.6	0.53	52	0.02	-------	-------	
	12,000	184.0	−50.6	-------	50	0.02	-------	-------	
5:11	12,424	174.9	−50.6	0.00	50	0.02	-------	-------	
5:12	12,577	170.7	−50.6	0.00	50	0.02	-------	-------	

FEBRUARY 15, 1931

P.m.									
4:30	225	988.4	4.5	-------	47	3.96	sw.	5.8	4 St. Cu., W.
	500	952.0	2.2	-------	47	3.37	sw.	10.6	
4:32	1,000	897.5	−1.1	0.72	47	2.62	wsw.	15.9	A line of clouds passing over. Sky clear before and after the line passed. Balloon went into the line of clouds.
4:34	1,328	856.1	0.1	−0.37	42	2.58	wsw.	20.1	
	1,500	839.0	−0.3	-------	40	2.38	wsw.	21.3	
4:35	1,520	837.3	−0.5	0.31	40	2.34	wsw.	21.3	
4:36	1,724	817.7	0.5	−0.49	40	2.53	w.	20.5	
	2,000	788.0	−1.0	-------	47	2.65	w.	18.7	
4:37	2,020	785.0	−1.1	0.54	47	2.62	w.	18.4	
4:40	2,468	739.9	−0.7	−0.09	55	3.17	-------	-------	
	2,500	735.0	−1.0	-------	55	3.10	-------	-------	
	3,000	690.0	−5.3	-------	57	2.24	-------	-------	
4:44	3,050	687.1	−5.5	0.82	57	2.21	-------	-------	
	4,000	607.0	−11.4	-------	55	1.27	-------	-------	
4:53	4,621	561.4	−15.0	0.60	52	0.87	-------	-------	
	5,000	534.0	−18.0	-------	52	0.66	-------	-------	
4:59	5,783	479.5	−23.8	0.76	47	0.34	-------	-------	
	6,000	466.0	−25.5	-------	47	0.29	-------	-------	
	7,000	406.0	−33.0	-------	45	0.13	-------	-------	
5:08	7,879	357.6	−40.1	0.78	42	0.05	-------	-------	
	8,000	353.0	−40.7	-------	42	0.05	-------	-------	
	9,000	304.0	−47.6	-------	42	0.02	-------	-------	
	10,000	262.5	−54.4	-------	42	0.01	-------	-------	
5:16	10,338	251.5	−56.6	0.67	42	0.01	-------	-------	Tropopause.
5:17	10,924	228.0	−57.8	0.20	42	0.01	-------	-------	
	11,000	226.0	−57.3	-------	42	0.01	-------	-------	
5:18	11,297	215.5	−56.0	−0.48	42	0.01	-------	-------	
	12,000	193.0	−57.8	-------	42	0.01	-------	-------	
5:21	12,199	186.2	−58.6	0.29	42	0.01	-------	-------	
	13,000	164.5	−56.3	-------	42	0.01	-------	-------	
	14,000	140.5	−53.4	-------	42	0.01	-------	-------	
5:28	14,290	134.1	−52.6	−0.29	42	0.01	-------	-------	
	15,000	120.0	−52.5	-------	42	0.01	-------	-------	
	16,000	103.5	−52.2	-------	42	0.01	-------	-------	
5:30	16,019	102.2	−52.2	−0.02	42	0.01	-------	-------	
	17,000	87.8	−54.7	-------	42	0.01	-------	-------	
	18,000	75.5	−57.0	-------	42	0.01	-------	-------	
	19,000	64.6	−59.7	-------	43	(1)	-------	-------	
5:38	19,278	62.2	−60.4	0.25	43	(1)	-------	-------	
	20,000	55.0	−60.7	-------	43	(1)	-------	-------	
	21,000	47.0	−61.5	-------	43	(1)	-------	-------	
	22,000	39.9	−62.3	-------	42	(1)	-------	-------	
5:45	22,471	37.1	−62.6	0.07	42	(1)	-------	-------	
	23,000	33.8	−62.7	-------	42	(1)	-------	-------	
	24,000	29.0	−63.0	-------	42	(1)	-------	-------	
	25,000	24.7	−63.4	-------	42	(1)	-------	-------	
	26,000	21.1	−63.8	-------	42	(1)	-------	-------	
	27,000	17.8	−64.2	-------	42	(1)	-------	-------	
5:53	27,683	16.0	−64.4	0.08	42	(1)	-------	-------	

[1] Less than 0.01 mb.

TABLE 2.—*Tabulated data of sounding-balloon ascents at Royal Center, Ind., during February, 1931*—Continued

FEBRUARY 16, 1931

Time 90th mer.	Altitude, M. S. L.	Pressure	Temperature	$\frac{\Delta t}{100 m.}$	Humidity		Wind		Remarks
					Relative	Vapor pressure	Direction	Velocity	
P. m.	M.	Mb.	°C.		%	Mb.		M.p.s.	
4:07	225	981.2	0.5	-------	98	6.20	se.	2.7	Rain and snow and low clouds.
4:08	347	961.6	0.7	−0.16	100	6.42	-------	-------	
	500	945.0	1.0	-------	98	6.43	-------	-------	
4:09	663	925.9	1.3	−0.19	98	6.58	-------	-------	
4:11	1,000	889.0	0.5	0.24	100	6.33	-------	-------	
4:13	1,204	863.7	−1.1	0.78	100	5.58	-------	-------	
4:15	1,408	839.6	0.7	−0.88	100	6.42	-------	-------	
	1,500	830.0	0.3	-------	100	6.24	-------	-------	
	2,000	781.0	−1.8	-------	100	5.27	-------	-------	
4:23	2,326	746.7	−3.1	0.41	100	4.73	-------	-------	
	2,500	730.0	−4.1	-------	100	4.35	-------	-------	
	3,000	686.0	−6.3	-------	100	3.61	-------	-------	
4:29	3,131	673.8	−6.9	0.47	100	3.43	-------	-------	
4:30	3,254	664.2	−6.9	0.00	100	3.43	-------	-------	
4:38	3,998	602.7	−11.1	0.56	85	2.02	-------	-------	
	5,000	529.0	−17.9	-------	83	1.05	-------	-------	
4:48	5,131	517.8	−18.9	0.69	82	0.95	-------	-------	
	6,000	461.0	−25.1	-------	78	0.49	-------	-------	
4:57	6,018	458.0	−25.3	0.72	78	0.48	-------	-------	
5:05	6,885	405.6	−29.7	0.51	70	0.28	-------	-------	
	7,000	401.0	−30.5	-------	70	0.25	-------	-------	
5:13	7,558	368.5	−35.9	0.92	70	0.14	-------	-------	
5:19	7,987	345.7	−39.5	0.84	70	0.10	-------	-------	
	8,000	345.0	−39.8	-------	70	0.09	-------	-------	
5:23	8,333	328.6	−41.1	0.46	70	0.08	-------	-------	

FEBRUARY 17, 1931

P. m.									
4:06	225	983.1	4.9	-------	93	8.05	n.	2.0	10 St. N. Misting.
	500	951.0	2.7	-------	94	6.97	-------	-------	
4:08	826	918.0	0.6	0.72	98	6.25	-------	-------	
	1,000	892.5	−0.3	-------	98	5.84	-------	-------	Altitude of St. base 649 m., m. s. l.
	1,500	838.0	−3.0	-------	99	4.72	-------	-------	
4:11	1,693	817.5	−4.1	0.54	100	4.35	-------	-------	
4:11½	1,826	804.1	−3.5	−0.45	100	4.58	-------	-------	
	2,000	787.0	−4.1	-------	99	4.31	-------	-------	
	2,500	736.0	−5.8	-------	96	3.62	-------	-------	
4:16	2,723	716.1	−6.5	0.33	96	3.41	-------	-------	
	3,000	689.0	−7.9	-------	84	2.65	-------	-------	
4:18	3,121	678.5	−8.2	0.43	80	2.46	-------	-------	
4:22	3,728	628.6	−12.3	0.68	95	2.02	-------	-------	
	4,000	606.0	−13.8	-------	85	1.58	-------	-------	
4:27	4,641	554.6	−17.2	0.54	62	0.84	-------	-------	
	5,000	531.0	−19.9	-------	62	0.65	-------	-------	
	6,000	462.5	−27.0	-------	62	0.32	-------	-------	
4:36	6,217	446.7	−28.8	0.74	62	0.27	-------	-------	
	7,000	402.0	−34.5	-------	57	0.14	-------	-------	
4:41	7,288	384.6	−36.8	0.75	55	0.10	-------	-------	
4:44	7,895	351.9	−43.1	1.04	55	0.05	-------	-------	
	8,000	346.0	−43.8	-------	55	0.05	-------	-------	
	9,000	297.0	−50.0	-------	56	0.02	-------	-------	
	10,000	255.0	−56.2	-------	57	0.01	-------	-------	
4:53	10,353	242.0	−58.2	0.61	58	0.01	-------	-------	Tropopause.
	11,000	219.0	−57.6	-------	55	0.01	-------	-------	
4:55	11,180	212.7	−57.4	−0.10	54	0.01	-------	-------	

FEBRUARY 18, 1931

P. m.									
4:10	225	990.7	3.8	-------	90	7.22	nw.	2.7	10 St. NW.; lt. fog.
	500	959.0	1.6	-------	95	6.52	-------	-------	
4:12	775	928.7	−0.3	0.75	100	5.96	-------	-------	Altitude of St. base, 502 m., m. s. l.
	1,000	900.5	−1.3	-------	100	5.49	-------	-------	
	1,500	844.0	−3.6	-------	100	4.54	-------	-------	
4:16	1,612	834.6	−4.0	0.44	100	4.39	-------	-------	
	2,000	795.0	−6.1	-------	100	3.67	-------	-------	
	2,500	744.0	−9.3	-------	100	2.78	-------	-------	
4:20	2,713	722.8	−10.4	0.58	100	2.53	-------	-------	
4:20½	2,938	702.7	−10.0	−0.18	100	2.62	-------	-------	
	3,000	697.0	−10.0	-------	90	2.36	-------	-------	
4:22	3,167	681.2	−10.4	0.17	56	1.42	-------	-------	
4:23	3,529	650.1	−12.6	0.61	51	1.06	-------	-------	
4:24	3,626	642.8	−12.8	0.21	50	1.02	-------	-------	
4:24½	3,738	631.8	−13.6	0.71	48	0.91	-------	-------	
	4,000	611.0	−15.6	-------	53	0.84	-------	-------	
4:28	4,483	573.6	−19.6	0.80	62	0.68	-------	-------	
	5,000	536.0	−22.5	-------	42	0.34	-------	-------	
4:31	5,023	534.8	−22.5	0.54	41	0.34	-------	-------	
4:34	5,539	499.1	−27.0	0.87	37	0.19	-------	-------	
	6,000	467.0	−30.8	-------	38	0.13	-------	-------	
4:39	6,503	434.9	−35.2	0.85	37	0.08	-------	-------	
	7,000	406.0	−39.0	-------	40	0.06	-------	-------	
4:44	7,609	370.6	−44.0	0.80	44	0.04	-------	-------	
	8,000	349.0	−47.4	-------	42	0.02	-------	-------	
	9,000	300.5	−56.0	-------	40	0.01	-------	-------	
4:50	9,205	290.8	−57.8	0.86	40	0.01	-------	-------	Tropopause.
	10,000	258.0	−56.2	-------	38	0.01	-------	-------	
	11,000	221.0	−54.2	-------	38	0.01	-------	-------	
5:01	11,694	198.1	−52.9	−0.20	36	0.01	-------	-------	
	12,000	189.0	−52.8	-------	36	0.01	-------	-------	
	13,000	162.0	−52.8	-------	35	0.01	-------	-------	
5:11	13,913	139.8	−52.9	0.00	34	0.01	-------	-------	
	14,000	138.0	−53.0	-------	35	0.01	-------	-------	
	15,000	119.5	−53.7	-------	36	0.01	-------	-------	
	16,000	102.0	−54.6	-------	36	0.01	-------	-------	
5:20	16,172	90.3	−54.7	0.08	36	0.01	-------	-------	

TABLE 2.—*Tabulated data of sounding-balloon ascents at Royal Center, Ind., during February, 1931*—Continued

FEBRUARY 19, 1931

Time 90th mer.	Altitude, M. S. L.	Pressure	Temperature	$\frac{\Delta t}{100 m.}$	Humidity		Wind		Remarks
					Relative	Vapor pressure	Direction	Velocity	
P. m.	M.	Mb.	°C.		%	Mb.		M.p.s.	
4:15	225	989.6	2.5	------	88	6.43	nw.	5.4	Clouds at various levels at various times during afternoon, changing quickly. Altitude of St. base, 638 m., m. s. l.
4:16	399	968.5	1.7	0.46	90	6.21	nnw.	14.2	
	500	955.5	1.0	------	92	6.04	nnw.	18.0	
	1,000	899.9	−2.5	------	99	4.92	------	------	
4:18	1,068	890.8	−3.0	0.70	100	4.77	------	------	
4:19	1,259	869.5	−3.4	0.21	86	3.96	------	------	
	1,500	842.5	−5.4	------	89	3.47	------	------	
	2,000	790.0	−9.5	------	96	2.63	------	------	
4:23	2,348	755.9	−12.4	0.83	100	2.12	------	------	
	2,500	739.5	−12.4	------	84	1.78	------	------	
4:25	2,871	705.8	−12.4	0.00	45	0.95	------	------	
	3,000	693.0	−13.6	------	45	0.86	------	------	
	4,000	605.5	−22.7	------	41	0.33	------	------	
4:30	4,349	578.7	−25.9	0.91	40	0.23	------	------	
	5,000	529.0	−32.1	------	41	0.13	------	------	
	6,000	458.8	−41.5	------	42	0.04	------	------	
4:36	6,070	452.7	−42.2	0.95	42	0.04	------	------	
4:38	6,731	410.0	−48.9	1.01	42	0.02	------	------	
	7,000	396.0	−50.1	------	41	0.02	------	------	
4:40	7,214	380.8	−51.1	0.46	40	0.01	------	------	
4:43	7,690	353.9	−51.3	0.04	38	0.01	------	------	

FEBRUARY 20, 1931

Time 90th mer.	Altitude, M. S. L.	Pressure	Temperature	$\frac{\Delta t}{100 m.}$	Relative	Vapor pressure	Direction	Velocity	Remarks
P. m.									
4:17	225	993.7	3.0	------	70	5.31	nnw.	5.4	10 St. Cu., NNW. Altitude of St. Cu. base, 1,057 m., m. s. l.
	500	960.0	0.4	------	72	4.53	nnw.	13.3	
	1,000	902.0	−4.1	------	87	3.78	nnw.	7.8	
4:21	1,321	866.0	−7.2	0.93	80	2.67	------	------	
	1,500	846.0	−8.0	------	80	2.50	------	------	
4:22	1,703	825.1	−9.1	0.50	80	2.26	------	------	
4:23	1,770	817.6	−8.0	−1.64	81	2.53	------	------	
	2,000	794.0	−10.1	------	82	2.13	------	------	
4:24	2,117	780.9	−11.6	1.04	82	1.86	------	------	
4:26	2,307	751.6	−7.4	−1.50	80	2.63	------	------	
	2,500	742.5	−7.6	------	76	2.45	------	------	
4:27	2,652	727.7	−7.6	0.06	70	2.26	------	------	
	3,000	697.0	−10.0	------	68	1.78	------	------	
	4,000	612.5	−16.4	------	60	0.88	------	------	
4:36	4,417	580.0	−19.3	0.66	58	0.65	------	------	
4:37	4,488	573.7	−19.3	0.00	56	0.63	------	------	
	5,000	536.0	−23.4	------	54	0.40	------	------	
	6,000	467.0	−31.8	------	50	0.16	------	------	
4:46	6,181	455.0	−33.3	0.83	51	0.14	------	------	
	7,000	404.0	−40.3	------	50	0.06	------	------	
4:53	7,711	364.1	−46.2	0.84	48	0.03	------	------	
	8,000	349.5	−47.7	------	48	0.02	------	------	
	9,000	294.0	−54.0	------	48	0.01	------	------	
5:00	9,930	257.7	−58.9	0.57	47	0.01	------	------	Tropopause.
	10,000	255.0	−59.0	------	47	0.01	------	------	
5:02	10,389	239.7	−59.1	0.02	47	0.01	------	------	
	11,000	218.0	−55.2	------	47	0.01	------	------	
5:05	11,133	212.6	−54.2	−0.66	47	0.01	------	------	
	12,000	186.5	−53.9	------	46	0.01	------	------	
5:08	12,179	181.2	−53.8	−0.04	46	0.01	------	------	
	13,000	159.0	−56.1	------	45	0.01	------	------	
	14,000	136.0	−58.9	------	44	0.01	------	------	
5:19	14,499	125.1	−60.2	0.28	44	(1)	------	------	
	15,000	115.9	−60.8	------	44	(1)	------	------	
5:25	15,749	102.6	−61.9	0.14	44	(1)	------	------	

[1] Less than 0.01 mb.

FEBRUARY 21, 1931

Time 90th mer.	Altitude, M. S. L.	Pressure	Temperature	$\frac{\Delta t}{100 m.}$	Relative	Vapor pressure	Direction	Velocity	Remarks
P. m.									
4:12	225	997.5	6.0	------	61	5.70	sw.	0.9	Few Cl., W. ?; 1 Cu., NW.
	500	962.0	3.7	------	65	5.17	wsw.	1.8	
	1,000	907.0	−0.1	------	71	4.30	nnw.	3.6	
4:16	1,204	883.5	−1.9	0.81	75	3.92	nnw.	5.0	
	1,500	848.0	0.2	------	70	4.34	nnw.	5.5	
4:17	1,540	846.0	0.3	−0.65	70	4.37	nnw.	5.6	
	2,000	799.0	−0.3	------	62	3.70	nnw.	7.2	
4:19	2,111	789.4	−0.3	0.11	61	3.64	nnw.	8.9	
4:19½	2,244	775.3	0.3	−0.45	58	3.62	nnw.	9.6	
	2,500	748.0	−1.0	------	52	2.93	nnw.	9.0	
4:22	2,856	716.4	−2.9	0.52	46	2.21	nnw.	7.9	
	3,000	703.0	−4.0	------	47	2.06	nnw.	7.6	
4:23	3,376	672.4	−6.7	0.73	53	1.85	nnw.	7.1	
4:25	3,805	632.8	−6.3	−0.09	55	1.99	nw.	7.6	
	4,000	618.0	−7.9	------	54	1.70	nw.	8.6	
	5,000	544.0	−15.8	------	51	0.79	nw.	11.9	
4:30	5,498	509.8	−19.9	0.80	50	0.52	nw.	13.3	
	6,000	476.0	−23.5	------	48	0.36	wnw.	18.7	
	7,000	414.0	−31.0	------	47	0.16	wnw.	18.0	
4:36	7,089	409.0	−31.6	0.74	47	0.15	wnw.	18.2	
	8,000	358.0	−41.9	------	50	0.05	wnw.	21.2	
4:41	8,235	346.4	−44.5	1.13	50	0.04	wnw.	21.0	
	9,000	309.0	−49.5	------	48	0.02	wnw.	20.3	
4:45	9,485	286.5	−52.6	0.65	48	0.01	wnw.	20.8	
	10,000	264.5	−55.3	------	48	0.01	wnw.	21.9	
4:50	10,586	241.1	−58.4	0.53	48	0.01	wnw.	21.9	
	11,000	226.0	−60.2	------	48	(1)	wnw.	23.8	

[1] Less than 0.01 mb.

TABLE 2.—*Tabulated data of sounding-balloon ascents at Royal Center, Ind., during February, 1931*—Continued

FEBRUARY 21, 1931—Continued

Time 90th mer.	Altitude, M. S. L.	Pressure	Temperature	$\frac{\Delta t}{100 m.}$	Humidity		Wind		Remarks
					Relative	Vapor pressure	Direction	Velocity	
P. m.	M.	Mb.	°C.		%	Mb.		M.p.s.	
4:54	11,550	206.6	−62.5	0.43	48	(1)	wnw.	19.2	Tropopause.
	12,000	192.8	−59.6	------	48	0.01	w.	20.6	
4:57	12,180	186.8	−58.4	−0.65	48	0.01	w.	22.7	
	13,000	------	------	------	------	------	w.	20.2	
	14,000	------	------	------	------	------	w.	20.8	
	15,000	------	------	------	------	------	wnw.	18.0	
	16,000	------	------	------	------	------	w.	22.6	
	17,000	------	------	------	------	------	w.	14.6	
	17,321	------	------	------	------	------	w.	15.5	

[1] Less than 0.01 mb.

FEBRUARY 22, 1931

Time 90th mer.	Altitude, M. S. L.	Pressure	Temperature	$\frac{\Delta t}{100 m.}$	Relative	Vapor pressure	Direction	Velocity	Remarks
P. m.									
4:13	225	995.4	7.2	------	72	7.32	calm	------	10 A. St., W. ?.
	500	961.0	4.1	------	74	6.06	nnw.	0.6	
4:14	510	959.5	4.1	1.09	74	6.06	nnw.	0.7	
	1,000	907.0	−1.8	------	87	4.58	nnw.	2.2	
4:17	1,050	899.9	−2.2	1.17	88	4.49	nnw.	2.2	
4:19	1,458	853.0	−2.2	0.00	82	4.18	ese.	1.0	
	1,500	850.0	−2.3	------	81	4.10	e.	1.1	
	2,000	798.0	−3.7	------	70	3.15	w.	3.9	
	2,500	748.0	−5.0	------	60	2.42	wsw.	5.6	
4:24	2,800	720.9	−5.7	0.26	55	2.09	wsw.	6.0	
	3,000	703.0	−7.4	------	60	1.97	w.	6.7	
4:26	3,244	681.9	−9.2	0.79	67	1.88	w.	7.7	
4:27	3,386	670.1	−9.0	−0.14	72	2.06	w.	8.3	
	4,000	618.0	−12.3	------	82	1.75	------	------	
4:29	4,080	612.2	−12.6	0.52	82	1.71	------	------	
	5,000	541.0	−19.6	------	87	0.95	------	------	
4:36	5,845	482.0	−25.9	0.75	90	0.53	------	------	
	6,000	472.0	−27.2	------	90	0.46	------	------	
	7,000	411.5	−35.4	------	90	0.19	------	------	
4:43	7,487	382.6	−39.6	0.83	90	0.12	------	------	
	8,000	354.9	−43.9	------	90	0.07	------	------	
	9,000	305.0	−52.7	------	90	0.02	------	------	
4:52	9,384	287.4	−56.2	0.88	90	0.02	------	------	
	10,000	262.0	−59.7	------	90	0.01	------	------	
	11,000	224.0	−65.2	------	90	(1)	------	------	
4:58	11,149	219.2	−66.0	0.56	90	(1)	------	------	Tropopause.
5:02	11,924	192.7	−61.6	−0.57	87	0.01	------	------	
	12,000	190.8	−61.2	------	86	0.01	------	------	
5:05	12,995	163.0	−55.2	−0.60	84	0.02	------	------	
	14,000	138.8	−59.4	------	79	0.01	------	------	
5:12	14,260	133.3	−60.4	0.41	78	0.01	------	------	
	15,000	118.4	−62.2	------	80	0.01	------	------	
5:18	15,351	111.7	−63.1	0.25	80	0.01	------	------	
	16,000	100.2	−62.1	------	79	0.01	------	------	
5:23	16,157	97.6	−61.9	−0.15	78	0.01	------	------	
	17,000	85.2	−63.3	------	72	(1)	------	------	
5:28	17,034	84.8	−63.5	0.18	72	(1)	------	------	

[1] Less than 0.01 mb.

FEBRUARY 23, 1931

Time 90th mer.	Altitude, M. S. L.	Pressure	Temperature	$\frac{\Delta t}{100 m.}$	Relative	Vapor pressure	Direction	Velocity	Remarks
P. m.									
4:10	225	991.3	4.7	------	73	6.23	n.	5.4	6 Ci., W.; few Cu., NW.
	500	958.0	1.4	------	75	5.07	n.	5.5	
4:11	699	936.6	−0.6	1.12	76	4.42	n.	4.0	
4:12	943	910.1	−0.1	−0.20	82	4.97	w.	2.1	
	1,000	902.5	−0.7	------	83	4.79	sw.	1.9	
4:13	1,163	881.0	−2.0	0.86	84	4.35	sw.	1.9	
4:14	1,346	862.3	−2.2	0.11	80	4.06	wnw.	2.7	
	1,500	846.0	−2.3	------	77	3.90	nnw.	4.1	
4:17	1,826	813.0	−2.8	0.12	68	3.30	nnw.	4.6	
	2,000	795.0	−3.7	------	68	3.06	nnw.	4.9	
4:18	2,106	783.8	−4.0	0.43	68	2.99	nnw.	5.0	
	2,500	744.0	−7.3	------	63	2.09	nnw.	5.2	
4:21	2,519	740.7	−7.6	0.87	62	2.00	nnw.	5.2	
4:21½	2,693	725.9	−7.8	0.11	64	2.03	nnw.	6.0	
	3,000	698.0	−9.8	------	65	1.74	nnw.	7.4	
4:25	3,356	665.5	−11.9	0.62	66	1.46	n.	9.2	
4:27	3,733	633.2	−13.5	0.42	68	1.31	nnw.	6.5	
	4,000	612.0	−15.2	------	68	1.12	nnw.	6.0	
4:32	4,641	561.9	−19.7	0.68	68	0.73	nnw.	5.8	
4:34	4,865	546.1	−21.4	0.76	67	0.61	nnw.	6.8	
	5,000	537.0	−22.3	------	66	0.55	nnw.	7.5	
4:39	5,860	476.6	−29.0	0.76	60	0.26	nnw.	9.4	
	6,000	------	------	------	------	------	nnw.	9.2	
	7,000	------	------	------	------	------	nw.	12.3	
	8,000	------	------	------	------	------	wnw.	12.9	
	9,000	------	------	------	------	------	nnw.	11.5	
	10,000	------	------	------	------	------	nw.	9.3	
	11,000	------	------	------	------	------	wnw.	17.5	
	12,000	------	------	------	------	------	wnw.	17.0	
	13,000	------	------	------	------	------	w.	15.4	
	14,000	------	------	------	------	------	w.	22.5	
	15,000	------	------	------	------	------	w.	19.1	
	15,518	------	------	------	------	------	w.	20.2	

TABLE 2.—*Tabulated data of sounding-balloon ascents at Royal Center, Ind., during February, 1931*—Continued

FEBRUARY 24, 1931

Time 90th mer.	Altitude, M. S. L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
P. m.	M.	Mb.	°C.		%	Mb.		M.p.s.	
4:11	225	990.3	7.0	-------	50	5.01	ne.	4.9	Cloudless.
	500	958.0	4.7	-------	51	4.36	ne.	6.3	
4:13	893	914.1	1.2	0.87	52	3.46	ne.	6.1	
4:14	984	902.7	2.1	−0.99	48	3.41	ne.	5.8	
	1,000	901.0	2.0	-------	47	3.31	ne.	5.7	
4:15	1,209	878.7	1.7	0.18	45	3.10	ne.	4.7	
	1,500	846.0	0.5	-------	44	2.79	ne.	4.2	
4:17	1,846	810.3	−1.2	0.46	40	2.21	ne.	5.0	
4:18	2,004	795.3	−1.2	0.00	42	2.32	ene.	5.3	
4:20	2,423	751.1	−3.7	0.60	41	1.84	ene.	6.4	
	2,500	745.0	−3.8	-------	40	1.78	ene.	6.5	
	3,000	700.0	−4.9	-------	39	1.59	ene.	7.0	
4:22	3,050	693.5	−4.9	0.19	38	1.55	ene.	7.1	
4:23	3,223	679.9	−4.9	0.00	38	1.55	ene.	7.7	
	4,000	614.0	−9.9	-------	38	1.00	ene.	9.4	
4:30	4,784	555.1	−14.6	0.62	38	0.66	ene.	5.0	
	5,000	539.5	−16.4	-------	38	0.56	ene.	4.7	
4:35	5,901	477.4	−24.6	0.90	36	0.24	ne.	4.8	
	6,000	471.0	−25.2	-------	36	0.23	ne.	4.0	
	7,000	411.0	−31.8	-------	33	0.10	nne.	3.7	
4:42	7,308	392.7	−34.0	0.67	32	0.08	nne.	2.4	
	8,000	355.0	−41.0	-------	32	0.04	e.	1.9	
4:47	8,456	331.6	−45.8	1.03	32	0.02	sse.	2.8	
4:48	8,502	329.1	−45.8	0.00	32	0.02	sse.	2.9	
	9,000	304.0	−49.6	-------	32	0.01	se.	4.7	
4:52	9,802	269.4	−55.4	0.74	32	0.01	se.	8.6	
	10,000	262.0	−56.9	-------	32	0.01	se.	8.6	
4:57	10,873	227.5	−63.2	0.73	32	(1)	ese.	6.8	
	11,000	223.0	−64.6	-------	32	(1)	ese.	6.6	
4:58	11,067	220.4	−65.2	1.03	32	(1)	se.	6.4	Tropopause.
4:59	11,286	212.2	−65.2	0.00	32	(1)	sw.	6.8	
	12,000	189.0	−62.0	-------	32	(1)	wsw.	10.3	
5:06	12,929	162.4	−57.9	−0.44	32	(1)	w.	15.4	
	13,000	161.0	−57.8	-------	32	(1)	w.	15.2	
	14,000	136.0	−57.5	-------	32	(1)	w.	18.6	
5:13	14,765	120.1	−57.4	−0.03	32	(1)	-------	-------	
	15,000	116.0	−57.4	-------	32	(1)	-------	-------	
	16,000	99.0	−57.4	-------	32	(1)	-------	-------	
	17,000	84.5	−57.4	-------	32	(1)	-------	-------	
5:23	17,034	84.0	−57.4	0.00	32	(1)	-------	-------	
	18,000	72.5	−58.4	-------	31	(1)	-------	-------	
5:29	18,074	71.5	−58.7	0.12	31	(1)	-------	-------	

[1] Less than 0.01 mb.

FEBRUARY 25, 1931

Time 90th mer.	Altitude, M. S. L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
P. m.									
4:12	225	990.3	7.7	-------	71	7.46	nw.	5.4	Few Ci., SW. ?; 10 dense haze.
4:13	439	960.3	5.0	1.26	75	6.54	nw.	5.0	
	500	954.0	5.5	-------	78	6.59	nw.	4.8	
4:14	653	939.1	6.3	−0.61	68	6.49	wnw.	4.4	
	1,000	899.0	3.7	-------	70	5.57	nw.	4.5	
4:16	1,193	877.8	2.1	0.78	71	5.04	nw.	6.0	
	1,500	842.5	0.9	-------	78	5.09	nw.	7.1	
4:17	1,744	820.5	0.0	0.38	82	5.01	nnw.	6.7	
	2,000	792.0	−1.9	-------	80	4.18	nw.	5.4	
4:19	2,326	758.5	−4.1	0.70	79	3.44	nw.	7.1	
	2,500	742.0	−4.9	-------	74	3.01	nw	8.5	
4:20	2,683	723.6	−5.6	0.42	67	2.57	wnw.	8.9	
4:21	2,887	707.0	−5.4	−0.10	60	2.34	wnw.	8.6	
	3,000	694.0	−6.1	-------	57	2.00	wnw.	8.7	
4:26	3,958	616.6	−10.2	0.45	41	1.05	w.	10.2	
	4,000	612.0	−10.7	-------	41	1.01	w.	10.2	
	5,000	535.0	−20.0	-------	47	0.49	w.	9.5	
4:35	5,579	493.4	−25.5	0.94	50	0.30	wnw.	13.8	
	6,000	466.5	−28.4	-------	48	0.22	w.	15.2	
4:38	6,273	448.6	−30.1	0.66	46	0.17	w.	13.6	
	7,000	406.0	−35.8	-------	46	0.10	w.	15.4	
4:42	7,079	402.2	−36.3	0.77	45	0.09	w.	15.6	
	8,000	351.0	−43.2	-------	45	0.04	w.	20.0	
4:48	8,446	328.2	−46.7	0.76	44	0.03	w.	22.0	
	9,000	302.0	−51.2	-------	44	0.02	w.	24.6	
	10,000	258.0	−59.3	-------	44	0.01	-------	-------	
4:56	10,104	253.8	−60.0	0.80	44	(1)	-------	-------	
4:57	10,474	239.1	−61.8	0.49	46	(1)	-------	-------	Tropopause.
	11,000	221.5	−61.6	-------	46	(1)	-------	-------	
5:03	11,688	196.6	−61.4	−0.03	45	(1)	-------	-------	
	12,000	189.2	−59.1	-------	45	0.01	-------	-------	
5:06	12,373	179.0	−55.8	−0.82	45	0.01	-------	-------	
5:10	12,893	164.9	−54.1	−0.33	45	0.01	-------	-------	
	13,000	162.5	−54.1	-------	45	0.01	-------	-------	
5:14	13,872	141.6	−53.9	−0.02	45	0.01	-------	-------	
	14,000	139.2	−54.2	-------	45	0.01	-------	-------	
	15,000	118.8	−56.2	-------	44	0.01	-------	-------	
	16,000	101.6	−58.3	-------	43	0.01	-------	-------	

[1] Less than 0.01 mb.

TABLE 2.—*Tabulated data of sounding-balloon ascents at Royal Center, Ind., during February, 1931*—Continued

FEBRUARY 25, 1931—Continued

Time 90th mer.	Altitude, M. S. L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
P. m.	M.	Mb.	°C.		%	Mb.		M.p.s.	
5:27	16,422	95.0	−59.3	0.21	43	0.01	-------	-------	
	17,000	87.0	−58.9	-------	42	(1)	-------	-------	
5:31	17,483	80.9	−58.5	−0.08	42	0.01	-------	-------	

[1] Less than 0.01 mb.

FEBRUARY 26, 1931

Time 90th mer.	Altitude, M. S. L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
P. m.									
4:11	225	996.5	7.7	-------	41	4.31	nw.	3.1	1 Cu., NW.
	500	961.0	4.5	-------	42	3.54	nw.	4.9	
	1,000	905.0	−1.1	-------	43	2.40	nw.	4.1	
4:14	1,061	896.0	−2.1	1.14	43	2.21	nw.	4.0	Pressure record lost between 9,486 and 11,211 meters inclusive; the altitudes from 9,486 to 10,424 meters inclusive, were obtained from the 2-theodolite observation; the altitude 11,211 meters was obtained from the ascensional rate; pressures for levels from 9,486 to 11,211 meters inclusive were computed from altitudes and temperatures.
	1,500	849.0	−5.9	-------	46	1.72	nnw.	5.0	
4:16	1,724	826.5	−7.9	0.90	47	1.48	nnw.	5.8	
	2,000	798.0	−9.0	-------	40	1.14	nw.	6.3	
4:17	2,111	786.5	−9.5	0.41	39	1.07	nw.	6.8	
4:18	2,205	766.5	−9.1	−0.21	36	1.02	nw.	7.2	
	2,500	746.1	−10.1	-------	35	0.91	nw.	8.1	
4:19	2,601	736.9	−10.7	0.54	33	0.81	nw.	9.5	
4:20	2,866	712.4	−10.1	−0.23	30	0.78	wnw.	11.4	
	3,000	702.0	−11.1	-------	30	0.71	wnw.	11.7	
4:23	3,448	661.3	−14.9	0.82	30	0.47	wnw.	12.4	
	4,000	616.0	−17.0	-------	28	0.39	wnw.	19.0	
	5,000	540.0	−20.5	-------	27	0.27	wnw.	27.3	
4:31	5,018	538.4	−20.6	0.36	25	0.25	wnw	27.2	
	6,000	471.0	−28.7	-------	25	0.11	w.	30.4	
4:35	6,018	470.2	−29.0	0.84	25	0.11	w.	30.5	
4:39	6,691	427.5	−34.3	0.79	25	0.06	w.	32.3	
	7,000	408.0	−36.6	-------	25	0.05	w.	31.4	
	8,000	352.5	−44.3	-------	25	0.02	w.	36.1	
4:45	8,038	349.9	−44.6	0.76	25	0.02	w.	36.2	
	9,000	303.0	−51.2	-------	25	0.01	w.	33.4	
4:50	9,486	280.6	−54.6	0.69	25	0.01	w.	52.1	
	10,000	259.0	−58.9	-------	25	(1)	w.	45.1	
4:53	10,424	241.6	−62.4	0.83	25	(1)	wnw.	46.7	
	11,000	218.0	−64.7	-------	25	(1)	wnw.	54.0	
4:56	11,211	209.1	−65.5	0.39	25	(1)	wnw.	54.0	Tropopause.
	12,000	188.5	−62.6	-------	25	(1)	-------	-------	
	13,000	160.5	−58.3	-------	25	(1)	-------	-------	
5:05	13,420	149.9	−56.3	−0.42	25	(1)	-------	-------	

[1] Less than 0.01 mb.

FEBRUARY 27, 1931

Time 90th mer.	Altitude, M. S. L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
P. m.									
8:24	225	989.8	2.1	-------	89	6.32	se.	3.6	Cloudless.
	500	955.0	7.8	-------	72	7.62	-------	-------	
8:25	525	951.7	8.1	−2.03	70	7.56	-------	-------	
8:26	918	909.8	6.5	0.41	64	6.20	-------	-------	
	1,000	900.0	5.7	-------	64	5.86	-------	-------	
8:28	1,438	851.3	1.7	0.92	64	4.42	-------	-------	
	1,500	844.5	1.4	-------	58	3.92	-------	-------	
8:29	1,540	841.9	1.1	0.59	55	3.64	-------	-------	
	2,000	794.9	−2.0	-------	67	3.47	-------	-------	
	2,500	745.0	−5.8	-------	75	2.83	-------	-------	
8:34	2,723	725.4	−7.3	0.71	80	2.65	-------	-------	
8:35	2,938	706.3	−6.3	−0.47	64	2.31	-------	-------	
	3,000	701.0	−6.8	-------	-------	-------	-------	-------	
8:36	3,295	674.7	−8.3	0.56	-------	-------	-------	-------	
8:38	3,784	631.0	−10.9	0.53	-------	-------	-------	-------	
	4,000	618.0	−12.5	-------	-------	-------	-------	-------	
8:42	4,529	573.9	−16.9	0.81	-------	-------	-------	-------	
	5,000	540.0	−19.9	-------	-------	-------	-------	-------	
	6,000	470.5	−26.6	-------	-------	-------	-------	-------	
8:53	6,783	422.2	−31.9	0.67	-------	-------	-------	-------	
	7,000	410.8	−33.3	-------	-------	-------	-------	-------	
	8,000	352.5	−42.2	-------	-------	-------	-------	-------	
9:01	8,466	329.4	−45.9	0.83	-------	-------	-------	-------	
	9,000	304.0	−49.7	-------	-------	-------	-------	-------	
	10,000	262.0	−56.8	-------	-------	-------	-------	-------	
9:09	10,537	240.0	−60.7	0.71	-------	-------	-------	-------	
	11,000	223.0	−61.9	-------	-------	-------	-------	-------	
9:11	11,036	222.0	−61.9	0.24	-------	-------	-------	-------	Tropopause.
	12,000	189.0	−61.7	-------	-------	-------	-------	-------	
9:17	12,153	184.6	−61.7	−0.02	-------	-------	-------	-------	
	13,000	161.5	−58.2	-------	-------	-------	-------	-------	
9:22	13,321	153.9	−56.9	−0.41	-------	-------	-------	-------	
	14,000	137.5	−58.8	-------	-------	-------	-------	-------	
9:25	14,030	137.0	−58.9	0.28	-------	-------	-------	-------	
	15,000	127.8	−59.5	-------	-------	-------	-------	-------	
9:35	15,733	104.5	−59.9	0.06	-------	-------	-------	-------	
	16,000	102.0	−59.6	-------	-------	-------	-------	-------	
9:41	16,483	93.1	−58.9	−0.13	-------	-------	-------	-------	
	17,000	85.5	−60.8	-------	-------	-------	-------	-------	
9:47	17,263	82.3	−61.9	0.38	-------	-------	-------	-------	

TABLE 2.—*Tabulated data of sounding-balloon ascents at Royal Center, Ind., during February, 1931*—Continued

FEBRUARY 28, 1931

Time 90th mer.	Altitude, M. S. L.	Pressure	Temperature	$\frac{\Delta t}{100 \text{ m.}}$	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
P. m.	*M.*	*Mb.*	*°C.*		%	*Mb.*		*M.p.s.*	
4:19	225	988.5	5.8	-------	89	8.21	n.	7.2	10 A. St., WSW.
4:19½	469	958.9	4.2	0.66	93	7.67	nne.	8.8	
	500	955.0	4.5	-------	91	7.66	nne.	8.8	Clouds thinning overhead during flight.
4:20	581	946.2	6.4	−1.96	88	8.46	nne.	8.6	
4:21	745	929.2	7.6	−0.73	78	8.14	ne.	8.3	
4:22	949	904.0	7.2	0.20	67	6.81	ne.	3.7	
	1,000	900.0	7.0	-------	66	6.61	ne.	3.0	
4:23	1,255	871.7	5.2	0.65	60	5.30	ne.	3.0	
	1,500	844.0	3.3	-------	66	5.11	ne.	3.4	
	2,000	796.0	−0.9	-------	80	4.54	ene.	4.1	
4:29	2,397	755.4	−4.0	0.81	90	3.95	ne.	4.3	
	2,500	746.0	−3.9	-------	78	3.45	ene.	3.6	
4:30	2,530	743.3	−3.8	−0.15	70	3.12	ene.	3.5	
	3,000	700.0	−7.0	-------	77	2.62	ne.	6.0	
4:33	3,335	672.5	−9.0	0.65	81	2.32	nne.	3.5	
4:33½	3,478	657.6	−9.8	0.56	81	2.16	n.	3.0	
4:34	3,560	648.8	−11.0	1.46	70	1.68	n.	3.1	

TABLE 2.—*Tabulated data of sounding-balloon ascents at Royal Center, Ind., during February, 1931*—Continued

FEBRUARY, 28, 1931—Continued

Time 90th mer.	Altitude, M. S. L.	Pressure	Temperature	$\frac{\Delta t}{100 \text{ m.}}$	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
P. m.	*M.*	*Mb.*	*°C.*		%	*Mb.*		*M.p.s.*	
4:35	3,764	631.7	−10.4	−0.29	60	1.52	nnw.	3.7	
	4,000	614.0	−12.4	-------	62	1.31	nnw.	3.5	
4:40	4,529	571.3	−17.0	0.86	67	0.93	nnw.	4.2	
4:42	4,896	546.6	−19.2	0.60	63	0.71	wnw.	3.4	
	5,000	539.0	−19.0	-------	62	0.71	w.	3.6	
4:43	5,090	531.6	−18.4	−0.41	61	0.74	wsw.	3.7	
4:47	5,865	477.1	−25.4	0.90	64	0.39	wsw.	4.2	
	6,000	470.0	−26.4	-------	64	0.36	wsw.	4.6	
4:50	6,650	428.5	−30.3	0.62	69	0.26	-------	-------	
4:52	6,905	415.0	−30.7	0.16	70	0.25	-------	-------	
	7,000	409.0	−31.5	-------	70	0.23	-------	-------	
	8,000	353.0	−40.6	-------	70	0.08	-------	-------	
5:00	8,201	341.8	−42.4	0.90	70	0.07	-------	-------	
	9,000	302.0	−51.0	-------	69	0.02	-------	-------	
	10,000	258.0	−61.3	-------	66	0.01	-------	-------	
5:09	10,047	256.9	−61.8	1.05	66	0.01	-------	-------	

SERIOUS EROSION CAUSED BY HEAVY RAIN OF JULY 30, 1931, NEAR COLFAX, WASH.[1]

By W. A. ROCKIE

On July 30, 1931, the weather conditions near Pullman, Wash., were such as would normally result in a severe thunder storm. A heavy cumulus cloud formed and hung to the west of town for several hours during the afternoon and evening. The storm cloud did not advance eastward toward Pullman as would normally be expected in this region but instead it expended its force and violence practically where it formed. There was but a trace of rain at Pullman; Lewiston had 0.02; Colfax had 0.21; Lacrosse had 0.14; Moscow had 0.06; but none of these points were in the area of the real rain. The real storm occurred over an area of about 50 square miles centering around the point where the Colfax-Almota road crosses Union Flat Creek. No severe rain occurred more than 5 miles from this point. This area is located about 10 miles west of the erosion station farm.

According to climatological data for the Washington section [2] precipitation was recorded on this date at 30 out of 105 stations listed in the Eastern Washington division (approximately eastern three-fifths of the State). The same publication of the Idaho section [3] shows that rain occurred on the same day at 64 out of 103 stations in the State of Idaho. The wide extent and very generally rainy tendency on this date in both Washington and Idaho, even though the rains were generally of negligible amount, shows that conditions were very favorable for precipitation in all parts of the region. The records of both Washington and Idaho are shown because Pullman is only a few miles from the Idaho line.

On the following day the Spokane newspaper contained a very graphic account of a "cloud-burst" that occurred on the area mentioned. The newspaper accounts of this rain were all centered upon the damage to personal property and to physical improvements located in great part downstream from the points where the heaviest rain fell. These reports were apparently very conservatively stated. In fact, they did not begin to tell the story of the damage that had actually occurred.

The several succeeding days were spent examining the area which had suffered from this rain storm. According to all information and evidence the heavy rain must have lasted only a very short period. Verbal accounts of the time of the rain itself differ considerably within the region affected. The only accurate record which we were able to obtain regarding the amount of rain which fell was obtained from Mr. W. P. Gilbert a farmer living just inside the limits of the area which showed evidence of the heavy rainfall. At his house, which was very close to the northeastern edge of the storm, 1.6 inches were recorded in 20 minutes, while on a more distant part of his farm 1 mile to the westward his measuring gage (a straight-sided can) actually caught 3 inches of water. He was at the house during the rain. While it is quite possible that more rain fell at some individual spots within the area than these records indicate we have not been able to secure any other figures. Mr. Gilbert has been keeping rainfall records at his farm in past years and we believe that his records are reliable.

The farm land within the area is typical of Palouse topography and is characterized by Palouse silt loam soil. It has fully as rough a topography as the average within the region, having many cultivated slopes in excess of 50 per cent gradient. The dominant farm crop rotation in the area is winter wheat and summer fallow. Some other crop conditions which were observed following the storm were spring wheat, alfalfa, bunch grass pasture, and fall wheat seeded in summer for summer pasture. A complete survey of the crop conditions was not attempted so other crops were also undoubtedly present.

The damage done to the land through erosion by this heavy rain was directly related to the vegetation which covered any given field on that date. The summer fallow land eroded to plow sole but did not generally go below that line. Individual fields containing several

[1] The writer wishes to express appreciation to P. C. McGrew, agricultural engineer in the Bureau of Agricultural Engineering, for the photographic illustrations which accompany this article. 1. Superintendent, Pacific Northwest Soil Erosion Experiment Station at Pullman, Wash.

[2] Climatological data, Washington section, U. S. Weather Bureau, Vol. XXXV, No. 7, p. 53.

[3] Climatological data, Idaho section, U. S. Weather Bureau, Vol. XXXIV, No. 7, p. 33.

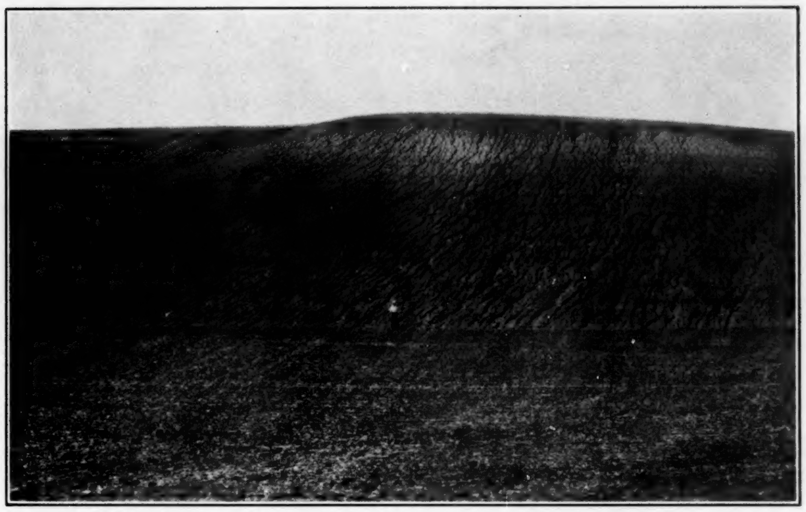


FIGURE 1.—Erosion from rain of July 30, 1931. Upper slope is fallow and lower slope is winter wheat planted late (probably about June 1) for summer pasture. This wheat was pastured close and is only 1 to 2 inches high but the root growth was very effective in stopping erosion. Location: SE. ¼ sec. 7, T. 15 N., R. 43 E., Whitman County, Wash. August 1, 1931. (Photo by P. C. McGrew)

FIGURE 2.—Erosion on 40 per cent slope of field in summer-fallow from rain of July 30, 1931. Ditches go to plow pan and are 5 to 10 inches deep. Location: Holbrook farm, sec. 21, T. 15 N., R. 43 E., Whitman County, Wash. (Photo by P. C. McGrew)

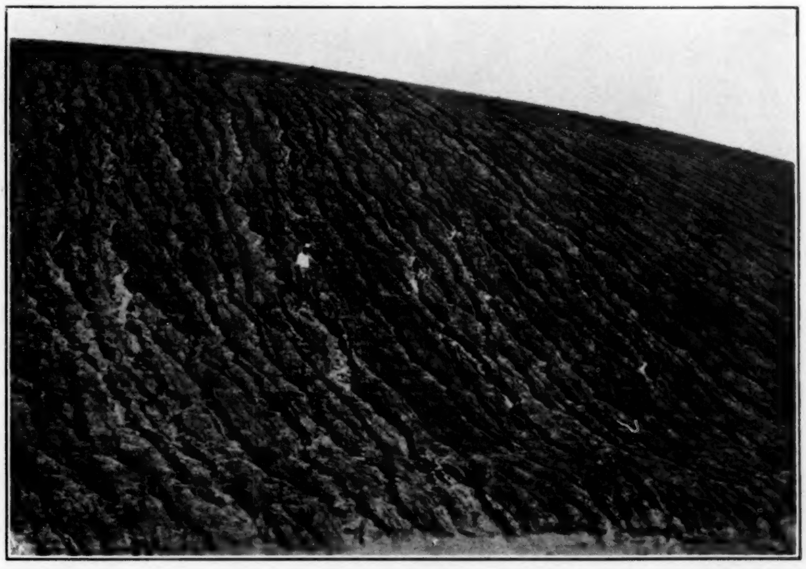


FIGURE 3.—Erosion on 40 per cent slope of field in summer-fallow from rain of July 30, 1931. Ditches go to plow pan and are 5 to 10 inches deep. Location: Holbrook farm, sec. 21, T. 15 N., R. 43 E., Whitman County, Wash. August 1, 1931. (Photo by P. C. McGrew)

UNIV. OF MICH.

hundred acres unquestionably lost as much as 2 inches of soil from their entire acreage. This has been estimated to have a distributed loss as follows: 25 per cent of the area lost 6 inches or more of soil and the remaining 75 per cent lost from 1 to 6 inches. It is firmly believed by the writer that no summer fallow land lost less than 1 inch of soil during the storm. Individual tracts of 1 acre were found which had lost 6 inches or more of soil over 90 per cent of that acre. Individual areas of one-tenth acre each were found to have lost from 8 to 10 inches of soil from 100 per cent of their area. The individual rivulets and gullies dug down as far as the soil had ever been loosened. On the farms where deeper plowing had been practiced the soil losses were, therefore, probably greater. The washing of the soil in summer-fallowed areas was found to have started within 15 feet and, in some instances, less distance from the ridge top. It appeared certain, therefore, that 15 feet of watershed was sufficient to start washing practically to plow pan and this destructive action tended to increase downward toward the draws.

The individual gullies washed in this loose-plowed soil were generally from 3 inches to 1 foot in width but with the slightest tendency toward a union of two or three or more of these smaller gullies a much more destructive condition resulted which produced thousands of gullies within the area from 5 to 10 feet in width with the plow sole as the gully floor. The side walls of these individual gullies were for the most part as nearly vertical as loose moist Palouse silt loam will stand.

The marks of the plow at the plow sole were plainly evident in all of these flat bottomed gullies. Since most of the plowing in the region is done with the contour this usually caused the plow marks to be perpendicular to the direction of the gulley but occasionally in flat basinlike areas at the foot of a steep slope these perfectly preserved marks of the plow on the heavy solid clay loam subsoil were very strikingly portrayed.

The wheat in some of the fields had just been harvested, while on others the ripe fall wheat or nearly ripe spring wheat was still standing. The same heavy rain falling on either stubble or standing ripe, or nearly ripe wheat, caused practically no damage. Occasionally sufficient surface water washed from a wheat field to form a definite channel on the slope knocking flat the wheat within that channel from its vertical position but in no instance was this stream found to have dug into the soil. Even this stream of water was the exception and on most of the wheat it appeared that the rain either went entirely into the ground or so much of it did so that there was not enough water run off to make rivulets of sufficient size to leave any evidence.

Several alfalfa fields were carefully examined and on none of them could the slightest evidence of soil washing be found. These alfalfa fields had new upright shoots of alfalfa which were usually less than 12 inches in height and rather scattering, since from July 1 up to the date of the rain the weather had been very dry. One field which had been seeded to alfalfa in the spring of this year had a rather sparse growth, and even this did not show any soil or water losses from the slopes.

Similarly, a portion of a field most of which had been left in summer fallow had been seeded in early summer to fall wheat for summer pasture. From the nipped condition of all of this wheat pasture it was apparent that it had been pastured continuously during the entire summer period and practically no spears of the plants were as much as one inch above the ground surface. This pasture area occupied a draw and the lower half of the steep adjoining slopes. Above on both slopes was summer fallow. The summer fallow was completely riddled by thousands of shallow gashes but these gashes stopped exactly at the upper edge of the wheat pasture in all instances; there were no exceptions.

Certain areas were found where summer fallow occupied the head of a watershed, some totaling a very few acres, others hundreds of acres. On certain areas summer fallow was found to cover the ridges, with ripe wheat or some other crop on the lower slopes. In other instances this condition was reversed, thus giving a complete check on just what part each vegetative condition played in the control of this great amount of water dumped onto the land in a very short time. No matter what topographic position the summer fallow occupied, erosion began within a few feet of the upper edge or upper level of the summer fallow, and in like manner no matter what topographic position the vegetative cover occupied, evidence of erosion of the soil ceased upon entering any vegetative area.

The physical evidence of the speed with which the rain fell and the flood formed and flowed away is best illustrated by the following facts. From a 3-acre watershed of summer fallow a violent stream of mud about 40 feet wide laid flat a standing crop of wheat in the draw which drained these 3 acres. After the flood had passed numerous soil "bowlders" were found lodged all along this draw for as far as 1,500 feet from the summer fallow. These bowlders consisted of the rounded cores of huge clods of dry black surface soil from the summer fallow which had been picked up, dragged along the bottom of the flood for distances up to 1,500 feet, and worn into true rounded "bowlders." All these movements were accomplished before these "bowlders" had a chance to moisten, else they would have disintegrated to loose, mellow soil. Had they been of clay subsoil material, this would not necessarily be true, but with black Palouse silt loam, such "bowlders" could form only of dry, hard material.

It mattered not what that vegetation was, how steep the slope might be nor how much momentum the flood had been given by a long slope of summer fallow above, the erosion stopped when vegetation was encountered. Further than that all vegetation which had any appreciable height acted as a strainer or filter causing the silt, which was being carried in suspension by the run-off waters, to settle. The result of this was that wherever a flood of water from summer fallow went through any vegetative area there remained afterward a freshly deposited silt layer on top of the old soil surface. The depth of this layer naturally decreased as the distance from the summer fallow increased.

These observations all indicate one fact, namely, that vegetative growth is a most effective control of soil washing and of run-off moisture losses.

The individual characteristics of each vegetative type or plant are undoubtedly factors of importance in this regard, but no study was made of these details.

STORM DAMAGE AT COLUMBUS, OHIO, JANUARY 26, 1932

By ORVILLE E. RUSSELL

[Weather Bureau, Columbus, Ohio]

A storm with winds of damaging force and certain tornadic characteristics occurred at Columbus, Ohio, on January 26, 1932. One person was injured and the value of the property destroyed was estimated to be between $3,000 and $4,000.

Nearly all the damage was reported from two different sections of the city and, although the two sections are separated by a distance of about 5 miles, the damaging winds occurred at nearly the same time in the two places. The damage reported from other sections of the city was of a minor nature and was confined to billboards, wires, trees, etc.

The greater portion of the damage occurred in a section near the center of the city and a mile and a quarter directly north of the Weather Bureau station. The damage at this point extended from Summit Street, in a northeasterly direction, diagonally across Hamlet Street and East Second Avenue and into North Fourth Street. Slight damage was caused to a residence on the west side of Summit Street and a billboard was blown down on the east side of the street. From this point the path crossed a vacant space about one block in extent. On the east side of Hamlet Street the roofs of the upper story porches on an 8-family duplex row were carried away and deposited in the street to the northeast of the building. On the north side of East Second Avenue the south wall of the second story of a 2-story brick dwelling was blown in. The brick and débris of the wall fell over a bed in which a woman and her 9-year-old daughter had just retired. The woman was painfully injured but the little girl was unhurt. At another residence on the north side of East Second Avenue, a falling chimney crashed through the roof and directly to the northeast, on the west side of North Fourth Street, a brick wall extending about 3 feet above the roof of a row of 2-story flats was blown eastward crashing the verandas of the entrances to six of the apartments in the row. The wall formed a false front to the row of apartments and the portion of the wall blown over was about 60 feet in length, a portion of the false front remained intact at either end of the building.

The débris from the roofs and brick walls had been cleared from the streets immediately so that when the scene was visited it was impossible to detect whether or not there had been any whorl as would be expected in a tornado. However, the path of destruction was remarkably straight and narrow and the direction was from the southwest to the northeast. The total length of the path was about 1,000 feet—a part of it being over vacant, treeless ground—and the width about 60 feet.

The other scene of destruction was at a point almost directly east of the Weather Bureau station and about 4½ miles distant. Here a frame barn was completely wrecked, the foundation blown clean, and the various parts of the building with its contents—rye straw in part—scattered over more than an acre of ground. This place is located on the east edge of the city and the dwellings are far apart which probably accounts for the fact that only the one building was damaged directly by the wind. The barn was located about 70 feet to the southwest of the dwelling and a large section of the barn, possibly the flooring in the loft, was hurled against the dwelling, smashing in a small porch on the southwest corner of the house. A piece of timber from the barn, 2 by 4 inches and about 5 feet long, was hurled endways almost through the second-story wall of the frame dwelling.

The strong southeasterly component of the wind was clearly shown by the destruction of the barn. In fact, the building seems to have been crushed by a force from the southeast and then caught up immediately by the southwest wind and scattered towards the northeast. A large piece of the siding of the barn, weighing possibly 500 pounds, was carried clear of the ground to a point about 100 feet directly north of the cement foundation. Another portion of the building weighing about 200 pounds was thrown to the northwest of the foundation, about 50 feet away. This latter object was in a position indicating clearly that it had been carried by a southeasterly wind. A small fruit tree standing several feet to the northwest of the foundation caught the straw in its branches and the position of the straws shows that the final direction of the wind was from the southwest. Several other small orchard trees standing to northwest, north, and northeast of the barn foundation also caught the long rye straws in their branches and the straws were drawn tightly over the branches and pointing northeasterly.

The various instruments at the station indicated that the wind shift line passed over between 10:35 p. m. and 10:40 p. m. The lowest station pressure was 28.79 inches about 10:30 p. m,. the fall from noon being about 0.45 inch. At the time of the shift the barograph pen rose suddenly for about 0.05 inch and then continued in a steady, rapid rise. The temperature dropped 8° or 9° from about 45°, in less than 30 minutes. The surface wind had been steadily from the southeast for several hours and shifted to the south at 10:35 p. m. and to the southwest about 3 minutes later. For two minutes the wind was from the southwest about this time and then became steady from the southwest. The maximum velocity recorded at the station was 30 miles from the southwest at 10:40 p. m. with an extreme velocity of 31 miles. Light rain fell during a considerable portion of the day with a small amount of hail when the wind shifted. No thunder was heard during the storm but thunderstorms were reported from the southern portion of the State on the evening of the 26th.

The weather map showed a weak LOW over western Nebraska on the morning of the 26th. At 7:40 p. m. a center was located a short distance south of Indianapolis and on the morning of the 27th it appeared near Canton, N. Y., so that the center of the disturbance was probably passing to the northeast at a point about 100 miles north of Columbus at the time of the storm winds. Between the time of the p. m. observation of the 26th and the a. m. observation of the 27th the center of the LOW apparently shifted over a distance of more than 600 miles or at a rate of over 50 miles per hour. By the morning of the 28th the LOW had increased considerably in intensity and moved to a position near Newfoundland with a center below 29 inches.

STICKEL ON THE MEASUREMENT AND INTERPRETATION OF FOREST-FIRE WEATHER IN THE WESTERN ADIRONDACKS[1]

By WELBY R. STEVENS

The author summarizes the results of an investigation made jointly at Cranberry Lake, N. Y., by the New York State College of Forestry and the Northeastern Forest Experiment Station.

The study was initiated in the early summer of 1925 and was carried on for a period of seven months annually (April through October) up to and including 1929. The author had three main objectives in view:

(a) To study the relation between forest fire hazard and weather conditions; (b) to determine whether current conditions of hazard can be estimated by means of simple meteorological instrumentation; and (c) to show in a general way the application of such an index of hazard and weather forecast to specific problems of fire control.

The first objective led to an investigation of the influence of the various weather elements on the inflammability of forest fuels, particularly that of the duff layer. Since inflammability and the rate of spread of fire depend largely upon the amount of water present in the combustible materials, duff moisture is an important factor in fire danger. This factor, however, is not observed at weather stations. For this reason, the author has attempted to devise some means of correlating certain weather elements with duff moisture so that meteorologists can estimate and forecast fire hazard by the use of ordinary meteorological instruments only.

After thorough investigation, it was found that the best index of duff moisture content is afforded by the three factors jointly, air temperature, number of hours since last measurable rainfall, and evaporation per hour. The relationship between these variables was obtained by means of curvilinear multiple correlation, and the resulting equation solved by means of an alinement chart. For observations taken at 2 p. m. the alienation index is 0.499, which means that 49.9 per cent of the variability of duff moisture content is due to factors other than those named. It is unfortunate, from the meteorologist's point of view, that evaporation per hour is such an important factor, because that element also is not observed at weather stations.

An intensive study of duff inflammability was made with different kinds of fire brands. From this investigation the author obtained the following inflammability chart:

Degree of hazard	Surface duff moisture content	Effective fire brands
Extreme	Below 6 per cent	Cigarettes, locomotive sparks, pipe heels, matches, and camp fires.
High	6–10 per cent	Locomotive sparks, pipe heels, matches, and camp fires.
Medium	11–16 per cent	Pipe heels, matches, and camp fires.
Low	17–22 per cent	Matches and camp fires.
Very low	23–29 per cent	Camp fires—duff at edges will smolder but not spread much.
Generally safe	30 per cent or more	None; generally safe from all.

This bulletin contains a wealth of information valuable to the meteorologist who is engaged in fire-weather work.

[1] Bulletin of the New York State College of Forestry at Syracuse University. Technical Publication No. 34.

BIBLIOGRAPHY

C. FITZHUGH TALMAN, in charge of Library

RECENT ADDITIONS

The following have been selected from among the titles of books recently received as representing those most likely to be useful to Weather Bureau officials in their meteorological work and studies:

Boerema, J.

Regenval in Nederlandsch-Indië (Rainfall in the Netherlands Indies.) Batavia. 1931. vol. 1. Mean rainfall figures for 3,293 rainfall stations in the Netherlands Indies calculated from observations made during the period 1879–1928. 244 p. 26½ cm. (K. Mag. en met. observ. Batavia. Verhand. no. 24.) vol. 2. Maps of the mean annual and monthly rainfall in Sumatra, with a map showing the position of rainfall stations. 14 charts. 51 cm.

Commission pour l'étude des pollutions de l'atmosphère.

Rapport général. [Antwerp]. 1931. 44 p. 36 cm. [Fatal effects of the fog in the Meuse valley. December, 1930.]

Congreso internacional de oceanografía, hidrografía marina e hidrologia continental.

Sevilla, 1–7 mayo 1929. Tomo 2. Madrid. 1931. 322 p. figs. plates (part fold.) 27 cm.

Coyecque, Marcel.

Notions de météorologie générale et nautique et éléments d'océanographie à l'usage de la marine et de l'aéronautique. Paris. 1931. xviii, 502 p. figs. plates. maps. 23 cm. (2e. éd., revue et aug.)

[Germany.] Marineleitung.

Nautischer Funkdienst. 1931. Zusammenstellung aller für den Bordgebrauch wichtigen Angaben über das Funkwesen. Zehnte Auflage . . . Berlin. 1931. 920 p. plates (fold.) 23½ cm.

Hurst, H. E., & Phillips, P.

Nile basin. vol. 1. General description of the basin, meteorology, topography of the White Nile basin. Cairo. 1931. xi, 144 p. plates (part fold.) 28 cm. (Physical dept. paper no. 26.)

Köppen, W.

Grundriss der Klimakunde. Zweite, verbess. Auflage der Klimate der Erde. Berlin. 1931. xii, 388 p. figs. plates (part fold.) 20½ cm.

Marbgraf, H., & Dobers, E.

Die Wetterkarte im neuzeitlichen Unterricht. 1. Teil: Die Zyklone. Hamburg. 1931. 11 p. charts. 29 cm.

Meseguer y Marín, Enrique.

Horario y características de los radiogramas meteorológicos dependientes del servicio meteorológico Español. Madrid. 1931. 8 p. 24 cm. (Serv. met. Español. ser. C, No. 5.)

Neue Augscurger Zeitung.

Professor Piccards Forschungsflug in die Stratosphäre; verlauf des Stratosphärenfluges und dessen wissenschaftliches Ergebnis . . . Augsburg. 1931. 128 p. front. illus. plates. ports. 22 cm.

Utah. Flood commission.

Torrential floods in northern Utah, 1930. Logan. [1931]. 51 p. illus. 23 cm. (Utah state agric. coll. Agr. exp. sta. Cir. 92, Jan., 1931.)

SOLAR OBSERVATIONS

SOLAR RADIATION MEASUREMENTS, JANUARY, 1932

By HERBERT H. KIMBALL

At Washington, D. C., Madison, Wis., and Lincoln, Nebr., the Weather Bureau has installed Marvin pyrheliometers with which, when the sky is free from clouds, measurements of the intensity of direct solar radiation at normal incidence are obtained.

At Washington the measurements are made on the campus of the American University about 5½ miles northwest of the United States Capitol, 3 miles northwest of the central office of the Weather Bureau, and 1½ miles northwest of the United States Naval Observatory. There are no manufacturing establishments within a radius of about 3 miles, but the suburb about the university is rapidly building up, principally with detached houses. The pyrheliometer is exposed on a shelf outside a window, in the morning on the southeast side of the building and in the afternoon on the southwest side. At times, with southeast or east winds, city smoke is brought over the university.

At Madison the pyrheliometer is installed in North Hall, University of Wisconsin, and exposed on a shelf outside a window facing east in the morning and west in the afternoon. North Hall is on a bluff in the upper campus, a short distance from the south shore of Lake Mendota. Most of the manufacturing plants are in the eastern part of the city, but railroad tracks and the heating plant of the university are to the southwest. With a northwest wind the air is free from smoke, but with the wind from other directions considerable smoke is brought over the campus.

At Lincoln the pyrheliometer is exposed in the experiment station building, on the farm campus, State University Farm. It is 2½ miles northeast of the center of the business section of the city, but there is some smoke from buildings on the farm campus and from railroads and shops not far to the north. Under certain conditions the city smoke cloud covers the farm campus, but with a west to northwest wind the atmosphere is very clear. When observing, the pyrheliometer is exposed on a shelf outside a south dormer window.

Besides these measurements of the intensity of direct solar radiation at normal incidence, continuous records of the intensity of the solar radiation received on a horizontal surface, including that received diffusely from the sky, are obtained at eight Weather Bureau stations, and at five additional stations, through cooperation with the Bureau of Entomology, United States Department of Agriculture (Twin Falls, Idaho), with the Scripps Institution of Oceanography (La Jolla, Calif.), and with the Universities of Florida (Gainesville), Miami (Belle Isle), and Tulane (New Orleans).

For descriptions of these various pyrheliometers and registers the reader is referred to Weather Bureau Circular Q, Pyrheliometers and Pyrhelimetric Measurements, Washington, 1931.

The pyrheliometers for recording the total radiation are generally exposed on the roof of a building where they have free exposure to the entire hemispherical vault of the sky. At Chicago the exposure is on the tower of Rosenwald Hall, University of Chicago, and at New York on the tower of the New York Meteorological Observatory in Central Park. At both these stations there is considerable depletion of the radiation by smoke. This is also true, but to a less degree, at Madison and Lincoln. During 1931 the pyrheliometer at Tulane University was considerably shaded by trees and surrounding buildings. With the first of the present year it was moved to the roof of the medical building, where it has an excellent exposure.

All pyrheliometers from which records are summarized in Tables 1 and 2 have been standardized by comparison with Marven pyrheliometer No. 3, except the Callendar instrument at Miami, which has a standardization certificate furnished by the English manufacturer. Quite probably this certificate gives radiation intensities on the Ångström scale, which is 3.5 per cent lower than the Smithsonian scale, with which Marvin No. 3 is made to agree by frequent comparisons.

The coordinates of the different stations and the instruments employed are as follows:

Stations	Instruments	Registers	Latitude	Longitude	Altitude
			° ′	° ′	*Feet*
Washington, D. C.	Marvin		38 56 N.	77 05 W.	397
	Eppley	Engelhard			414
Madison, Wis	Marvin		43 05 N.	89 23 W.	974
	Callendar	Callendar			1,009
Lincoln, Nebr	Marvin		40 50 N.	96 41 W.	1,225
	Callendar	Callendar			1,250
Chicago, Ill	Eppley	Engelhard	41 47 N.	87 35 W.	688
New York, N. Y	do	do	40 46 N.	73 58 W.	156
Fresno, Calif	do	do	36 43 N.	119 49 W.	330
Pittsburgh, Pa	do	do	40 32 N.	80 02 W.	1,114
Fairbanks, Alaska	do	do	64 52 N.	147 39 W.	500
Twin Falls, Idaho	do	do	42 29 N.	114 25 W.	4,300
La Jolla, Calif	Weather Bureau	do	32 50 N.	117 15 W.	85
Miami, Fla	Callendar	Callendar	25 41 N.	80 12 W.	
Gainesville, Fla	Moll	Richard	29 39 N.	84 21 W.	233
New Orleans, La	Eppley	do	29 56 N.	90 07 W.	100

Beginning with February, 1932, measurements of the intensity of direct solar radiation have been obtained through the red and yellow glass screens recommended by the Commission on Solar Radiation of the International Geodetic and Geophysical Union at its conference at Berlin and Potsdam, February 23–26, 1931.[1]

The screens were obtained through Doctor Süring, director of the Potsdam Magnetic-Meteorological Observatory. A Weather Bureau thermoelectric pyrheliometer, exposed in a Marvin pyrheliometer mounting, with the two glass screens taking the place of the blades of the shutter at the outer end of a diaphragmed tube, is employed in the measurements.

The equatorial clock-driven mounting keeps the tube pointed quite accurately towards the sun, but hand adjustment is frequently made. The electrical mechanism designed to rotate the shutter a quarter turn each minute is operated by hand at such time intervals as are desired, usually about 10 minutes, to successively measure the current when there is no screen between the pyrheliometer and the sun, and when the yellow and the red screens are alternately interposed. At the same time a Marvin pyrheliometer, exposed near the thermoelectric pyrheliometer, is continuously read.

The thermoelectric pyrheliometer at present records on a Leeds and Northrup recording potentiometer, and a comparison of the record obtained when no screen is interposed with synchronous readings of the Marvin pyrheliometer makes it possible to reduce millivolts of current generated in the thermopile of the pyrheliometer to gram calories per minute per square centimeter of radiation intensity. In the thermopile in use a radiation intensity of one gram calorie per minute per square centimeter generates a current having an e. m. f. of about 7.20 millivolts.

[1] Kimball, Herbert H. The radiation conference at Berlin and Potsdam, Feb. 23–26, 1931. Mo. Wea. Rev., May, 1931, Vol. 59, pp. 187–188.

The first measurements with the screens will be summarized in the February number of the REVIEW.

Table 1 shows that solar radiation intensities measured at normal incidence were above the normal intensity for January at Washington, slightly below the January normal at Madison and at Lincoln in the morning, but above the normal at Lincoln in the afternoon. The depression in intensities at Lincoln during the morning hours was undoubtedly due to smoke, which was carried away by the wind later in the day.

Table 2 shows a deficiency in the total solar radiation received on a horizontal surface at all stations for which normals have been computed except at Miami, Fla., Fresno and La Jolla, Calif., where an excess was recorded.

No skylight polarization measurements were made at Madison, Wis., as there was a trace of snow on the ground during most of the month, which produces a disturbing effect. At Washington, measurements made on three days give a mean of 62 per cent with a maximum of 66 per cent on the 18th. These are slightly above the respective averages for Washington in January.

TABLE 1.—*Solar radiation intensities during January, 1932*

[Gram-calories per minute per square centimeter of normal surface]

Washington, D. C.

Date	8 a.m. 75th mer. time	A. M. 78.7°	A. M. 75.7°	A. M. 70.7°	A. M. 60.0°	0.0°	P. M. 60.0°	P. M. 70.7°	P. M. 75.7°	P. M. 78.7°	Noon Local mean solar time
	e.	5.0	4.0	3.0	2.0	[1] 1.0	2.0	3.0	4.0	5.0	e.
	mm.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	mm.
Jan. 2	5.79		0.79	1.01							5.16
Jan. 11	3.30	0.40									3.45
Jan. 14	8.18	0.86	0.99	1.14	1.20						9.47
Jan. 18	3.30						1.30	1.15			3.30
Jan. 20	3.15			1.12	1.28			1.11	0.95	0.81	3.63
Jan. 25	2.49	0.85	0.96	1.14	1.38		1.30	1.11	0.99	0.85	2.49
Jan. 27	5.36			1.10			1.30	1.15	1.01	0.90	3.45
Means		0.70	0.91	1.10	1.29		1.30	1.13	0.98	0.85	
Departures		−0.03	+0.06	+0.09	+0.06		+0.07	+0.09	+0.09	+0.05	
Madison, Wis.											
Jan. 18	2.36							1.20	1.06		2.36
Jan. 20	3.99		0.74	0.82							3.81
Jan. 25	2.36		1.00	1.16	1.31			1.08			2.87
Jan. 27	3.15						1.42	1.29			2.06
Means			(0.87)	(0.99)	(1.31)		(1.42)	1.19	(1.06)		
Departures			−0.17	−0.21	−0.02			−0.01	±0.00		
Lincoln, Nebr.											
Jan. 8	1.52							1.26	1.16	1.07	1.52
Jan. 17	1.78							1.23	1.07	1.00	2.74
Jan. 18	1.68	0.76	1.05	1.18				1.22	1.07	0.95	2.16
Jan. 19	3.45							1.15	1.00	0.83	4.57
Jan. 23	2.49	1.00	1.12	1.25	1.41	1.60		1.27	1.16	1.06	2.16
Jan. 25	1.78	0.97	1.00								2.87
Jan. 27	1.68	0.63	0.81	1.04	1.32			1.12	0.95		3.30
Jan. 28	2.49							1.07	0.95	0.85	2.16
Jan. 29	1.02	1.11	1.22				1.48	1.34	1.20	1.14	0.74
Means		0.89	1.04	1.16	(1.36)	(1.60)	(1.48)	1.21	1.07	0.99	
Departures		−0.04	−0.01	−0.02	−0.01		+0.14	+0.04	+0.02	+0.06	

[1] Extrapolated.

TABLE 2.—*Total solar radiation (direct + diffuse) received on a horizontal surface*

[Gram-calories per day per square centimeter

Week, beginning	Washington	Madison	Lincoln	Chicago	New York	Fresno	Pittsburgh	Fairbanks	Twin Falls	La Jolla	Gainesville	Miami	New Orleans
	Average daily totals												
	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.
Jan. 1	89	59	120	41	50	217	70	4.5	113	272	240	324	74
Jan. 8	143	69	161	69	95	143	131	5.8	155	248	263	324	148
Jan. 15	178	116	188	89	118	210	99	5.3	146	274	223	331	236
Jan. 22	163	155	237	139	120	269	75	26.9	223	318		397	171
	Departures from weekly normals												
Jan 1	−61	−72	−60	−37	−52	+65	−22		−57	+37	−24	+26	
Jan. 8	−10	−71	−29	−12	−7	−19	+33		−29	+12	+18	+29	
Jan. 15	+18	−43	−12	−6	+5	+20	−10		−50	+31	−16	+39	
Jan. 22	−15	−31	+13	+30	−14	+54	−40		+33	+66		+85	
	Accumulated departures on Jan. 28												
	−476	−1,519	−616	−175	−476	+840	−273		−271	+1,022		+1,253	

POSITIONS AND AREAS OF SUN SPOTS

[Communicated by Capt. J. F. Hellweg, Superintendent United States Naval Observatory. Data furnished by Naval Observatory, in cooperation with Harvard, Yerkes, Perkins, and Mount Wilson observatories. The differences of longitude are measured from central meridian, positive west. The north latitudes are plus. Areas are corrected for foreshortening and are expressed in millionths of sun's visible hemisphere. The total area, including spots and groups, is given for each day in the last column]

Date	Eastern standard civil time		Heliographic Diff. long.	Longitude	Latitude	Area Spot	Area Group	Total area for each day
1932	H	m	°	°	°			
Jan. 1 (Naval Observatory)	11	41	+26.0	243.2	−13.0	108		108
Jan. 2 (Naval Observatory)	10	38	−17.0	187.6	+4.5		31	
			+38.5	243.1	−13.0	123		154
Jan. 3 (Mount Wilson)	11	15	−70.0	121.1	+11.0	9		
			−4.0	187.1	+4.0		10	
			+50.0	241.1	−13.0	107		126
Jan. 4 (Mount Wilson)	17	10	−55.0	119.6	+11.0		6	
			+69.0	243.6	−14.0	152		158
Jan. 5 (Mount Wilson)	11	0	+80.0	244.9	−14.0	218		218
Jan. 6 (Mount Wilson)	11	30	−30.0	121.6	+13.0		8	8
Jan. 7 (Yerkes Observatory)	12	54	No spots					
Jan. 8 (Perkins Observatory)	11	45	No spots					
Jan. 9 (Perkins Observatory)	10	30	No spots					
Jan. 10 (Naval Observatory)	10	25	No spots					
Jan. 11 (Naval Observatory)	10	28	No spots					
Jan. 12 (Naval Observatory)	12	16	No spots					
Jan. 13 (Naval Observatory)	12	53	No spots					
Jan. 14 (Naval Observatory)	10	38	No spots					
Jan. 15 (Naval Observatory)	10	33	+13.0	46.5	−8.5		31	31
Jan. 16 (Naval Observatory)	11	10	+27.0	47.0	−8.0		108	108
Jan. 17 (Yerkes Observatory)	12	15	+38.4	44.6	−9.6	6		
			+38.9	45.1	−9.2	6		
			+40.2	46.4	−6.5	6		
			+43.6	49.8	−10.4	30		48
Jan. 18 (Naval Observatory)	10	38	+57.0	50.9	−9.5	25		25
Jan. 19 (Naval Observatory)	11	13	+69.0	49.4	−10.0	9		9
Jan. 20 (Naval Observatory)	11	6	No spots					
Jan. 21 (Naval Observatory)	12	3	−72.0	241.6	−12.0	81		81
Jan. 22 (Mount Wilson)	11	25	−60.0	240.7	−14.0		127	
			+36.0	336.7	+16.0		13	140
Jan. 23 (Yerkes Observatory)	14	59	−44.6	241.1	−13.3	138		
			−41.8	243.9	−13.6	3		
			+54.4	340.1	+14.8	28		169
Jan. 24 (Naval Observatory)	13	35	−33.0	240.3	−12.0	108		108
Jan. 25 (Naval Observatory)	10	32	−21.5	240.3	−13.0	53		
			+27.0	288.8	−6.0		37	90

POSITIONS AND AREAS OF SUN SPOTS—Continued

Date	Eastern standard civil time		Heliographic			Area		Total area for each day
			Diff. long.	Longitude	Latitude	Spot	Group	
1932	H	m	°	°	°			
Jan. 26 (Mount Wilson)	12	0	−72.0	175.8	+13.0	211		
			−31.0	216.8	+0.5		7	
			−8.0	239.8	−13.0	154		
			+24.0	271.8	+8.0		27	
			+41.0	288.8	−6.0		22	421
Jan. 27 (Naval Observatory)	10	17	−64.0	171.6	+12.5	247		
			+5.0	240.6	−13.0	62		309
Jan. 28 (Naval Observatory)	11	42	−50.0	171.7	+12.5	108		
			+18.0	239.7	−13.0	77		185
Jan. 29 (Perkins Observatory)	--	--	−36.0	171.5	14.5	96		
			+30.5	238.0	−10.0	80		176
Jan. 30 (Naval Observatory)	12	46	−22.0	172.7	+13.0	123		
			+46.0	240.7	−13.0	62		185
Jan. 31 (Naval Observatory)	11	36	−9.5	172.7	+12.5	108		
			+59.0	241.2	−13.0	77		185
Mean daily area for January								98

PROVISIONAL SUN-SPOT RELATIVE NUMBERS, JANUARY, 1932

(Dependent alone on observations at Zurich and its station at Arosa)

[Data furnished through the courtesy of Prof. W. Brunner, University of Zurich, Switzerland]

January, 1932	Relative numbers	January, 1932	Relative numbers	January, 1932	Relative numbers
1	12	11	0?	21	d 8
2	25	12	0	22	18
3	----	13	0	23	17
4	8	14	Mc —	24	16
5	8	15	10	25	25
6	0?	16	15	26	d 42
7	0?	17	12	27	a 36
8	----	18	8	28	18
9	0	19	7	29	18
10	7	20	0	30	18
				31	17

Mean, 28 days=12.3.

a=Passage of an average-sized group through the central meridian.
b=Passage of a large group or spot through the central meridian.
c=New formation of a center of activity: E, on the eastern part of the sun's disk; W, on the western part; M, in the central circle zone.
d=Entrance of a large or average sized center of activity on the east limb.

AEROLOGICAL OBSERVATIONS

[The Aerological Division, W. R. GREGG, in charge]

By L. T. SAMUELS

The free-air temperatures for the month were decidedly above normal at most stations and levels. (See Table 1.) At Dallas, Ellendale, and Omaha, negative departures in the lower levels changed to positive at higher elevations. At the more eastern stations the positive departures were exceptionally large while at San Diego they were negative at all levels.

Relative humidities were mostly above normal in the lower levels and below normal in the upper levels.

The resultant winds at 1,000-meter elevation were southerly as compared to a westerly normal in the northern Gulf region. Elsewhere, the monthly values did not differ appreciably from the normals for this level. At 2,500 meters the westerly component predominated in the monthly resultants. A marked exception occurred at this level at Key West, where the monthly resultant was easterly while the normal is westerly. However, at 3,000 meters at this station the monthly resultant was south-southwesterly as compared to a normal west-southwesterly.

TABLE 1.—*Free-air temperatures and relative humidities during January, 1932*

TEMPERATURE (°C.)

Altitude (meters) m. s. l.	Chicago, Ill.[1] (190 meters)		Cleveland, Ohio[1] (245 meters)		Dallas, Tex.[2] (149 meters)		Due West, S. C. (217 meters)		Ellendale, N. Dak. (444 meters)		Hampton Roads, Va.[3] (2 meters)		Omaha, Nebr.[4] (299 meters)		Pensacola, Fla.[3] (2 meters)		San Diego, Calif.[3] (9 meters)		Washington, D. C.[3] (2 meters)	
	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal
Surface	−1.0	+3.3	2.8	+7.1	5.5	−0.7	9.4	+3.5	−13.3	−2.2	10.6	+3.3	−8.1	−2.1	14.8	+3.8	11.8	−1.3	5.8	+5.6
500	−1.7	+3.7	2.5	+7.9	6.3	+0.5	9.7	+3.8	−12.8	−1.8	9.5	+2.8	−7.3	−1.2	14.1	+3.5	9.7	−1.9	6.5	+6.3
1,000	−2.4	+3.0	1.1	+6.5	7.2	+1.5	8.5	+3.5	−8.6	+0.2	7.7	+3.0	−4.7	−0.1	12.5	+3.2	7.8	−2.1	5.6	+6.4
1,500	−2.2	+3.7	0.1	+6.0	6.3	+1.3	6.7	+3.2	−7.6	+0.5			−3.0	+1.1						
2,000	−3.0	+3.9	−1.7	+5.2	4.8	+1.4	5.3	+3.6	−9.5	+0.1	4.8	+3.8	−3.7	+1.7	9.2	+2.6	3.5	−1.9	3.2	+6.6
2,500	−4.9	+3.8	−3.8	+4.9	3.0	+1.7	5.1	+5.3	−11.3	+0.5			−5.8	+1.8						
3,000	−7.0	+4.0	−5.9	+5.1	0.6	+1.7	2.5	+4.9	−14.3	+0.1	0.7	+3.7	−8.0	+2.1	5.6	+3.0	0.5	−0.5	0.1	+6.6
4,000	−12.2	+3.6	−10.6	+5.2	−5.4	+1.2			−19.9	−0.1			−14.0	+1.4						
5,000			−17.2	+5.4	−12.1	+0.6							−20.9	+0.6						

RELATIVE HUMIDITY (PER CENT)

Altitude (meters) m. s. l.	Chicago Mean	Chicago Departure	Cleveland Mean	Cleveland Departure	Dallas Mean	Dallas Departure	Due West Mean	Due West Departure	Ellendale Mean	Ellendale Departure	Hampton Roads Mean	Hampton Roads Departure	Omaha Mean	Omaha Departure	Pensacola Mean	Pensacola Departure	San Diego Mean	San Diego Departure	Washington Mean	Washington Departure
Surface	84	+5	80	+1	83	+6	85	+14	87	+6	76	+1	86	+4	86	+4	62	−1	74	+4
500	82	+7	80	+5	75	+5	76	+13	84	+5	76	+6	83	+4	80	+5	59	−1	61	−1
1,000	76	+11	79	+14	64	+3	69	+12	70	+4	71	+6	73	+7	74	+7	52	0	56	−2
1,500	61	+3	70	+12	55	+1	64	+11	62	+3			61	+2						
2,000	53	0	67	+14	49	0	56	+7	50	+1	51	+1	53	−4	62	+9	40	0	49	−3
2,500	52	−1	64	+11	44	−2	40	−5	57	−1			52	−4						
3,000	50	−4	60	+6	42	0	47	+4	58	0	37	−2	51	−5	54	+10	30	+1	34	−9
4,000	42	−13	54	−1	38	0			61	+7			43	−10						
5,000			51	−8	41	+5							38	−16						

[1] Normals for Royal Center, Ind., used.
[2] Normals determined by interpolating between those for Groesbeck, Tex., and Broken Arrow, Okla.
[3] Naval air stations.
[4] Normals for Drexel, Nebr., used.

TABLE 2.—*Free-air resultant winds (meters per second) based on pilot balloon observations made near 7 a. m. (E. S. T.) during January, 1932*

[Wind from N=360°, E=90°, etc.]

Altitude (meters) m. s. l.	Albuquerque, N. Mex. (1,528 meters)		Brownsville, Tex. (12 meters)		Burlington, Vt. (132 meters)		Cheyenne, Wyo. (1,873 meters)		Chicago, Ill. (198 meters)		Cleveland, Ohio (245 meters)		Dallas, Tex. (154 meters)		Due West, S. C. (217 meters)		Ellendale, N. Dak. (444 meters)		Havre, Mont. (762 meters)		Jacksonville, Fla. (14 meters)		Key West, Fla. (11 meters)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°	
Surface	26	0.8	153	0.5	215	2.1	293	5.2	255	2.9	221	4.7	62	0.1	249	0.9	292	2.5	245	3.1	333	0.5	87	3.4
500			152	4.5	217	5.6			237	7.3	232	8.3	200	1.2	244	3.0	292	2.5			163	3.3	104	8.0
1,000			172	4.8	240	6.2			245	10.3	252	9.6	291	3.4	252	5.4	316	6.2	257	6.5	198	5.6	114	6.6
1,500			203	5.2	254	7.4			258	10.6	252	11.8	282	5.8	265	7.8	302	7.1	274	9.7	223	6.4	123	4.9
2,000	296	0.7	218	6.4	283	10.3	290	7.0	268	13.4	256	15.1	278	9.4	281	9.7	287	7.8	280	9.8	263	6.9	125	3.9
2,500	261	4.9	160	2.2			298	9.7			248	13.3	264	12.2	272	10.8	286	9.8	281	9.6	285	6.0	127	1.8
3,000	272	8.7					290	9.7					265	12.4			284	8.8	280	9.6			205	2.1
4,000	261	4.9					291	11.2					252	17.8										
5,000	280	13.3					265	11.0																

Altitude (meters) m. s. l.	Los Angeles, Calif. (217 meters)		Medford, Oreg. (410 meters)		Memphis, Tenn. (89 meters)		New Orleans, La. (25 meters)		Oakland, Calif. (8 meters)		Oklahoma City, Okla. (392 meters)		Omaha, Nebr. (299 meters)		Phoenix, Ariz. (356 meters)		Salt Lake City, Utah (1,294 meters)		Sault Ste. Marie, Mich. (198 meters)		Seattle, Wash. (14 meters)		Washington, D. C. (10 meters)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°	
Surface	357	1.3	206	0.5	167	1.5	41	2.0	76	0.2	201	0.7	331	1.7	125	1.3	156	24	305	1.0	156	1.0	318	1.8
500	58	1.1	262	0.6	218	4.5	103	2.8	348	3.4	220	2.6	306	3.1	102	1.7			307	2.6	182	3.8	283	6.8
1,000	27	2.9	164	1.5	249	6.5	203	3.7	347	7.0	255	6.8	286	5.8	107	0.4			286	1.0	194	5.0	293	10.2
1,500	27	4.7	194	1.2	259	7.5	266	3.8	339	7.4	258	7.7	269	8.1	258	1.5	186	2.7	271	3.6	221	3.8	287	12.2
2,000	2	6.1	243	2.6	262	8.5	254	7.6	336	7.6	260	9.5	275	9.3	256	3.2	219	1.8					284	16.3
2,500	334	6.6	257	3.6	261	9.1	257	8.9	340	8.1	256	10.4	273	11.2	265	4.6	265	2.6					283	14.7
3,000	330	7.5	250	2.6	247	11.5	258	10.0	337	7.5	259	13.7			271	7.7	291	5.2						
4,000	348	11.6	295	3.0					328	9.7					291	12.5								

WEATHER IN THE UNITED STATES

[Climatological Division, OLIVER L. FASSIG in charge]

THE WEATHER ELEMENTS

By M. C. BENNETT

The marked features of the weather for January, 1932, were the abnormally high temperature in the East and decidedly low temperature in the West.

The average temperature for the month ranged from 4° to 12° above normal east of the Great Plains, with the greatest departure above normal from the Ohio Valley northward, eastward, and southeastward, some stations in the Middle Atlantic States showing the warmest January in 100 years. On the other hand, the western portion of the country was decidedly cold, with the greatest deficiencies ranging from 5° to 10°.

The precipitation was generally heavy in sections having the warmest weather and was excessive in much of the south Mississippi Valley; large areas received from two to more than six times the January normal, while in marked contrast some nearby sections, as eastern Florida, southern Texas and the northern Plains received only 50 per cent or less of the usual amount. West of the Rocky Mountains precipitation was generally light, many sections receiving less than normal.

TEMPERATURE

The general situation in January was much the same as that prevailing since the middle of November, 1931; remarkable mildness continued in the eastern half, while low temperatures were the rule in the far West. The greatest temperature excess during January was found farther to northeastward than before, and the middle Plains region, instead of averaging warmer than normal, was now colder than normal.

The mildness in the eastern half was comparatively steady, while in the West the southern Plateau region was almost constantly colder than normal. The opening week was especially warm compared with normal in the north-central portion and particularly cold in Utah and districts adjacent. During the latter part of the first decade, while warmth continued in the East, temperatures above normal prevailed in the Pacific States and the far Northwest, particularly in Montana. The first half of the second decade had about the warmest weather ever known in January in the upper and middle Mississippi Valley and thence eastward to the Atlantic coast. However, the middle and latter portions of this decade were cold in most of the central and northern Plains and almost throughout the West.

The final decade of January began with warmer weather in Montana and the Plains, and with marked warmth continuing in the Lake region, the upper Ohio Valley, and to eastward, but with notable cold in most of the Plateau region. About the 28th a decided cold wave reached Montana and North Dakota whence it spread westward, southward, and eastward, so that the month closed with low temperatures prevailing in all but the southernmost States. The arrival of this cold wave ended in several districts prolonged periods remarkable for absence of low temperatures. For example, Harrisburg, Pa., had every day warmer than normal from December 10 to January 30, inclusive, January 13 being 32° warmer, and Keokuk, Iowa, reached 1° below zero on January 30, the first below-zero reading at that place since January 29, 1930, two year and one day earlier.

The month averaged warmer than normal in the eastern half of the country and in most of Oklahoma and Texas,

also in northern portions of North Dakota and Montana. The excess was large to eastward of the Mississippi River, averaging about 12° from the upper Ohio Valley eastward and northeastward. Usually in Michigan and near Lake Ontario, and almost invariably east of the Appalachian crest from the Carolinas to southern New England, this was the warmest January of record. At New Haven, Conn., it was the warmest January of 154 whose temperatures are known. Frequently in the Middle Atlantic States the departure from normal was found to be greater than the positive or negative departure of any other month of record at any season of the year.

In most of Nebraska and the central and western portions of Kansas and South Dakota, and practically throughout the Rocky Mountain States and the far West, save parts of Montana, the month averaged colder than normal. In Utah, Arizona, and eastern Nevada, the deficiency was 4° to 7° per day; Phoenix, Ariz., found this the coldest month whatever in a record of 36 years, save one December.

The highest marks were about 80° as far north as Maryland, Kentucky, and Arkansas, also in part of southern California; while in southern Texas 91° was noted. On the other hand, from Wisconsin to the Dakotas and in some Plateau States 60° was nowhere reached. In the western half the highest marks occurred usually on the 8th, or during the middle decade; in the eastern half usually on the 13th, 14th, or 15th. At this time, scores of stations near or east of the Mississippi River noted the highest January temperatures they had ever recorded.

The lowest marks in Florida, Mississippi, and Louisiana were in the twenties, and zero was not reached south of New York, Michigan, Illinois, Missouri, and Kansas. From Wisconsin to the Dakotas, however, and in most Rocky Mountain and Plateau States, the lowest was more than 30° below zero, one elevated station in Oregon even noting −41° on the 23d. In about two-thirds of the States, including nearly all of those wholly east of the Rocky Mountains, the lowest temperatures came on either the 30th or the 31st.

PRECIPITATION

For the nation as a whole, January was a month of ample precipitation. The distribution over the country was comparatively good; likewise the distribution through the month. However, the Atlantic and Gulf States received a large part of their monthly totals during the opening fortnight, and the central valleys about the middle of the month, while the closing week brought a large portion in California and Nevada, and in Tennessee and considerable parts of the States adjoining.

The monthly totals were decidedly greater than normal in Oklahoma and eastern Texas; indeed, in each of these States only one other January of record brought more than the present January. Kansas, southeastern Nebraska, and the western two-thirds of Iowa likewise had far more than normal. As a rule, there was much more than normal in the Ohio and lower Mississippi Valleys and moderately more than normal in southwestern Georgia and adjacent parts of other States, in the Middle Atlantic States and southern New England, and in the middle and western portions of the Lake region. Among the States, Mississippi and Louisiana had the greatest average amounts.

In the western half of the country there was usually somewhat more than normal in northeastern Wyoming and the western parts of the Dakotas, also in northern and eastern Nevada.

Precipitation was usually less than normal in northern California, central Montana, the eastern halves of the Dakotas, and especially in western and southern Arizona. The middle and lower Rio Grande Valley usually had less than normal precipitation, also the bulk of the Florida peninsula, and the immediate Atlantic coast to northward as far as Cape Hatteras. From central Missouri to southern Wisconsin there was generally less precipitation than in an average January.

As usual in winter, the largest monthly amount was reported by a station in Washington, 26.88 inches at Paradise Inn. East of the Rocky Mountain crest the greatest quantity was 17.82 inches at Swan Lake, Miss.

SNOWFALL

Once more the snowfall was very scanty from central and southern Missouri and northern Arkansas eastward over the Ohio Valley and southern Lake region to the Middle Atlantic States and southern New England. Many stations in this belt had decidedly less snow than ever before in January, and several, even as far north as Sandusky, Ohio, and Pittsburgh, Pa., had no measureable snow. Close to the Canadian boundary, as far west as Lake Superior, there was less than normal practically everywhere.

In a belt from southwestern Kansas northeastward to Minnesota the snowfall was decidedly heavy, often the greatest ever known in a January. The southern Rocky Mountain region and the central Plateau received, as a rule, far more than normal, and other parts of the far West usually had about as much as normal, save near the Canadian boundary, where the monthly totals fell short of normal. The supply of accumulated snow in the western mountains at the end of January was generally as great as or greater than normal, and in many districts the deepest for years, indicating a good stream flow during the coming spring and summer.

At Los Angeles, Calif., 2 inches of snow fell during the morning of the 15th, a greater amount than ever recorded there previously.

SUNSHINE AND RELATIVE HUMIDITY

Much cloudy weather prevailed in the region of the Great Lakes, the greater part of the New England States, the Great Central Valleys, Texas, and the northern portions of the Plateau and Pacific regions, while more than the usual amount of sunshine was received in the south Atlantic States, and in the southern portions of the Plateau and Pacific coast areas. Elsewhere about the average amount for January prevailed. The relative humidity was above the normal in the New England States, much of the South, and the central portions of the Great Plains the Rocky Mountain and Plateau regions, while elsewhere it was generally near or slightly below the seasonal average.

SEVERE LOCAL STORMS, JANUARY, 1932

[The table herewith contains such data as have been received concerning severe local storms that occurred during the month. A revised list of tornadoes will appear in the Annual Report of the Chief of Bureau]

Place	Date	Time	Width of path (yards)	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
Grand Rapids, Mich	1					Glaze	Considerable damage to telephone, electric, and power lines.	Official, U. S. Weather Bureau.
Eldridge (near), Tex	11	2:30 p. m.	50	2	$2,000	Tornado	4 small houses wrecked; implements damaged; 1 person injured.	Do.
Hockley (near), Tex	11	3:30 p. m.			30,000	do	4 buildings demolished, several damaged; poultry killed; telephone lines broken; several persons injured.	Do.
Port Angeles, Wash	11				15,000	Wind	7 fishing boats wrecked and a tug sunk	Do.
Montana	11				90,000	do	Damage confined chiefly to buildings, fences, signboards and trees; communication services interrupted; greatest destruction in southern division.	Do.
Hamilton, Miss., and vicinity.	12	4:30 p. m.		3	25,000	Probably tornado.	5 homes destroyed and practically all other buildings damaged; 30 persons injured.	Official, U. S. Weather Bureau, and Montgomery Advertiser (Ala.).
Murfreesboro, Tenn	12	7:30 p. m.				Wind	Trees uprooted; signboards blown down; warehouse unroofed.	Official, U. S. Weather Bureau.
Alabama (west-central)	12			10	65,000	Tornado	Many homes demolished; livestock killed; telephone service impaired.	Official, U. S. Weather Bureau, and Montgomery Advertiser (Ala.).
Alexander and Pulaski Counties to Richland and Lawrence Counties, Ill.	12				34,000	Wind	Wire service interrupted; roofs, plate glass, signs, and light buildings damaged; 2 persons injured.	Official, U. S. Weather Bureau.
Canyon City, Colo. (Wolf Park).	12				1,000	do	House wrecked; garage blown over	Do.
Chickasaw, Simpson, and Forrest Counties, Miss.	12					High winds and thunder-squalls.	Character of damage not reported	Do.
Indiana	12	P. m.			10,600	Wind	Buildings, smokestacks, and power lines damaged.	Do.
Millbrook, Ala., and vicinity.	12				12,000	Tornado	Many homes and other buildings destroyed or damaged; poultry killed.	Official, U. S. Weather Bureau, and Montgomery Advertiser (Ala.)
Columbus, Ohio, and vicinity.	13					Wind	Damage chiefly to roofs, windows, wires, and trees.	Official U. S. Weather Bureau.
Eaton (near), Tenn.	14	5.30 p. m.		10	75,000	Tornado	9 substantial buildings wrecked; several persons injured; path 8 miles long.	Do.
Grand Rapids, Mich	14-15				6,000	Thunderstorms	Dairy barn and contents destroyed by lightning; 3 horses killed.	Do.
Columbus, Ohio	26	10:30 p. m.	20		3,500	Probably tornado.	Buildings wrecked or damaged; billboards demolished; 1 person hurt; path about 400 yards long.	Do.
Evansville, Ind	26				2,000	Wind	Some damage to property	Do.
New York City, N. Y	27					do	Signs, windows, and trees damaged; 10 persons injured.	Do.

RIVERS AND FLOODS

By MONTROSE W. HAYES

[In charge River and Flood Division]

There were floods in January in the South Atlantic and Gulf States, in the Ohio Basin, and in the lower Mississippi Valley. In parts of Iowa, Missouri, and Oregon there were minor overflows of a local character. Some of the floods had not begun to recede at the end of January, and information concerning the others is not complete. A discussion of them will, therefore, appear in a later issue of the REVIEW.

WEATHER OF THE ATLANTIC AND PACIFIC OCEANS

[The Marine Division, W. F. McDONALD in charge]

NORTH ATLANTIC OCEAN

By F. A. YOUNG

Pressure.—As shown by Table 1, the average pressure at Reykjavik, Iceland, was 0.44 below normal, which indicates that the Icelandic LOW was unusually well developed, although during the last few days of the month there was an intrusion of high pressure in this region.

Along the coast of northern Europe, cyclonic conditions prevailed during the greater part of the first half of the month, while comparatively high barometric readings were the rule during the last decade, and the average pressure was not far from normal.

The North Atlantic HIGH was fairly well developed from the 4th to 8th, 13th to 17th, and 26th to 28th, while, as shown by Table 1, the average at Horta for the month is slightly below normal and at Madeira considerably above, indicating that the crest of this HIGH was some distance southeast of its usual position.

The daily barometric readings at Belle Isle and Halifax show the usual rapid changes that are to be expected in winter in that region, while at both of these stations there was a slight positive departure, for the month as a whole.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure (sea level) at selected stations for the North Atlantic Ocean and its shores, January, 1932*

Stations	Average pressure	Departure	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Julianehaab, Greenland [1]	29.44	([2])	30.00	[3] 29	28.78	13
Reykjavik, Iceland [1]	29.22	−0.44	30.33	30	28.23	15
Lerwick, Shetland Islands [1]	29.69	−0.01	30.68	26	28.76	6
Valencia, Ireland [1]	29.98	+0.08	30.81	27	28.81	10
Lisbon, Portugal [1]	30.36	+0.21	30.53	3	29.80	11
Madeira [1]	30.27	+0.17	30.44	[3] 5	29.96	25
Horta, Azores [1]	30.12	−0.04	30.38	13	29.75	3
Belle Isle, Newfoundland [1]	29.82	+0.02	30.22	27	28.96	31
Halifax, Nova Scotia [1]	30.06	+0.08	30.70	12	29.32	28
Nantucket [4]	30.10	+0.06	30.61	11	29.35	3
Hatteras [4]	30.20	+0.06	30.56	31	29.63	9
Bermuda [1]	30.22	+0.06	30.54	13	29.78	5
Turks Island [1]	30.10	+0.05	30.20	[3] 13	29.90	9
Key West [4]	30.11	+0.01	30.29	31	29.86	1
New Orleans [4]	30.13	0.00	30.53	31	29.68	29
Cape Gracias, Nicaragua [1]	29.93	−0.05	29.98	[3] 13	29.88	[3] 1

[1] All data based on a. m. observations only, with departures computed from best available normals related to time of observations.
[2] No normal available.
[3] And on other date or dates.
[4] Corrected 24-hour means, based on more than 1 observation daily.

Charts VIII, IX, X, and XI, show the conditions on the 12th, 17th, 27th, and 30th, respectively, when the severest storms of the month occurred.

During the first and last decades of the month, there were a number of moderate disturbances between the Bermudas and the American coast, and during these periods gales were also reported by a number of vessels between the Azores and fiftieth meridian.

The following extracts from news reports give an idea of the damage to life and property wrought by various storms off the coast of Europe and on the northern steamer lanes:

London, January 6.—Steamer *Jersey City*, buffeted by a 50-mile gale and mountainous seas, was drifting off the Scilly Isles to-day with her engines crippled.

London, January 10.—A gale raged the length of English Channel to-day and did considerable damage along the south coast of Great Britain.

Brooklyn Eagle, January 14.—Arriving many hours late due to storms, the North German Lloyd liner *Bremen* docked at her pier late last night. The *Bremen* left Cherbourg January 8, and found the weather fairly good until the 10th, when she encountered a west-northwest gale. For 20 hours thereafter, according to her commander, Capt. Leopold Zeigenbein, she was forced to run at reduced speed, with the wind of hurricane force. The next day, January 11, she was again forced to cut her speed, when the wind blew at times 100 miles an hour, accompanied by snow. Another 8-hour speed reduction on January 12, when a north-northwest snow storm, driven by terrific winds, sent big waves crashing across the liner's deck.

Brooklyn Eagle, January 20.—The Holland American liner *Veendam* docked this morning, a day and a half late as a result of the most severe Atlantic storm this winter. The following vessels were also delayed on account of heavy weather: German S. S. *Europa*, British S. S. *Antonia*, Italian M. S. *Vulcania*, French S. S. *France*, and American S. S. *American Merchant*.

Cyclones and gales.—According to the Pilot Chart January is usually the stormiest month of the year over the North Atlantic. Many cyclonic storms with wind of force 10 to 12 were reported during the current month, but the number of days with gales was slightly if any above the normal over the northern steamer lanes, although on a number of days the storm area extended unusually far south.

As to be expected in January the northern section of the ocean was traversed by one cyclone after another, and some of these were unusually deep and severe. South of the 50th parallel, the number of days with gales was fairly well distributed, and three vessels reported disturbances between the 25th and 30th parallels while, as shown in table of storms, the American S. S. *Tegucigalpa* encountered a "norther" of force 11, while at Vera Cruz, Mexico.

The lowest pressure since December, 1929, over the North Atlantic during an extratropical storm was recorded by the Norwegian S. S. *Bergensfjord*. While this vessel was in 58° N., 24° 55′ W., on the 17th, the corrected reading from the mercurial barometer was 27.81 inches, with highest force of wind 11. On the previous day the American S. S. *Quaker City* encountered a SW. wind, force 12, while in 58° 40′ N., 15° 18′ W. This was undoubtedly the severest storm of the month, although there were a number of others that were responsible for a great deal of damage.

Fog.—The number of days on which fog was reported in different sections of the ocean, is as follows: Along the American coast, between the 35th and 45th parallels, from 3 to 9 days. Over the Grand Banks, from 4 to 6 days. Over the steamer lanes, east of the 45th meridian, from 1 to 2 days. In the western section of the Gulf of Mexico, on 6 days.

OCEAN GALES AND STORMS, JANUARY, 1932

Vessel	Voyage		Position at time of lowest barometer		Gale began	Time of lowest barometer	Gale ended	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Direction and highest force of wind	Shifts of wind near time of lowest barometer
	From—	To—	Latitude	Longitude									
NORTH ATLANTIC OCEAN			° ′	° ′				Inches					
Charles H. Cramp, Am. S. S.	New York	Canal Zone	39 30 N	73 54 W	Jan. 1	3 a., 1	Jan. 1		E	E, 8	E	E, 10	Steady.
Nishima, Am. S. S	New Orleans	Bremen	48 42 N	26 38 W	Jan. 2	8 a., 2	Jan. 6	29.38	S	S, 7	WNW	—, 9	Variable.
Extavia, Am. S. S	Lisbon	New York	37 00 N	61 17 W	do	4 p., 2	Jan. 2	29.64	SSE	SSE, —	N	—, 10	SSE-NW.
Europa, Ger. S. S	Cherbourg	do	41 49 N	62 02 W	Jan. 3	4 p., 3	Jan. 4	29.38	ESE	N, 7	N	NE, 10	
Norwegian, Br. S. S	Liverpool	Bermuda	36 52 N	49 34 W	Jan. 1	6 a., 3	Jan. 5	29.65	NNW	S, 8	NE	WSW, 10	SW-W.
Lefcomo, Am. S. S	Galveston	Barcelona	36 10 N	25 10 W	Jan. 2	4 a., 3	Jan. 3	29.84	SW	SSW, 9	NW	—, 9	SSW-NW.
Elmsport, Am. S. S	Corpus Christi.	Liverpool	40 35 N	57 15 W	do	3 a., 4	Jan. 4	29.20	SE	NE, 10	NNW	NE, 10	NE-NNW.
Lobos, Br. M. S	Canal Zone	do	48 16 N	16 00 W	Jan. 1	3 a., 4	do	29.69	S	SSW, 9	W	SSW, 9	SSW-W.
Comanche, Br. S. S	Baytown	London	34 43 N	63 04 W	Jan. 4	1 p., 4	Jan. 6	29.73	NE	NE, 6	NE	—, 9	Steady.
Delshaven, Du. S. S	Rotterdam	Baltimore	29 46 N	52 48 W	Jan. 5	11 a., 6	do	29.86	NE	NE, 9	ENE	NE, 9	NNE-NE.
Wilhelm A. Riedemann, Danzig M. S.	Aruba	Southampton.	48 30 N	14 09 W	Jan. 4	—, 6	Jan. 7	29.48	SSW	WSW, 11	SSW	WSW, 11	WSW-WNW.
Prusa, Am. S. S	Sevilla	New Orleans	27 36 N	57 25 W	Jan. 6	4 p., 6	Jan. 7	29.86	NE	NE, 10	NE	NE, 10	
West Ekonk, Am. S. S	New Orleans	Liverpool	47 20 N	34 00 W	Jan. 8	8 p., 8	Jan. 11	29.25	SW	SW, 10	W	SW, 10	NW-SW.
Tegucigalpa, Hond. S. S	do	Vera Cruz	Vera Cruz, Mex.		do	8 & 9	Jan. 9	30.28	N	N, —	N	N, 11	Steady.
Elmsport, Am. S. S	Corpus Christi.	Liverpool	47 05 N	35 55 W	Jan. 7	5 a., 9	Jan. 10	29.63	WSW	NW, 8	NNW	WSW, 10	Do.
Bremen, Ger. S. S	Cherbourg	New York	50 00 N	18 00 W	Jan. 9	6 p., 9	do	28.72	SSW	WSW, 8	NW	NW, 10	SW-W-NW.
Montoso, Am. S. S	Porto Rico	Boston	39 40 N	70 00 W	do	7 a., 10	do	29.22	NNE	ENE, 10	N	N, 11	NE-ENE-NE.
West Camak, Am. S. S	Rotterdam	New Orleans	49 46 N	1 14 W	do	4 p., 10	Jan. 15	29.23	S	S, 9	SSW	S, 9	S-SW.
Meanticut, Am. S. S	Houston	Havre	39 05 N	74 16 W	Jan. 10	2 p., 11	Jan. 12	29.60	SSW	WSW, 9	NNW	NNW, 10	SW-W-NNW.
West Eldara, Am. S. S	Rotterdam	Boston	50 30 N	20 05 W	Jan. 12	6 p., 12	Jan. 14	29.05	SW	SSW, 10	W	SW, 11	SW-NW.
Nevada, Dan. S. S	South Shields	New York	57 34 N	20 45 W	do	Noon, 12	Jan. 15	28.23	SE	SSE, 8	W	WSW, 11	SE-S-W.
Elmsport, Am. S. S	Corpus Christi.	Liverpool	49 50 N	20 05 W	do	4 p., 12	Jan. 14	29.02	WSW	WSW, 10	WSW	WSW, 11	Steady.
France, Fr. S. S	Havre	New York	49 00 N	22 50 W	Jan. 14	Mdt., 15	Jan. 17	29.23	SW	SW, 9	NW	WNW, 10	
Motocarline, Belg. M. S	Baytown	Antwerp	43 40 N	45 54 W	Jan. 16	8 p., 16	Jan. 18	29.66	NNW	NNW, 7	NW	NNW, 9	NNW-NW.
Ala, Am. S. S	New York	Rotterdam	46 50 N	35 48 W	do	8 p., 16	do	29.31	W	SW, 10	NW	SW, 10	SW-W.
Quaker City, Am. S. S	Dundee	Philadelphia	58 40 N	13 28 W	do	6 a., 16	Jan. 20	29.25	S	—, 7	SW	—, 12	
Berlin, Ger. S. S	Bremerhaven	New York	49 42 N	20 00 W	do	8 p., 17	Jan. 22	29.50	SSW	SSW, 9	WNW	NW, 11	SSW-WNW.
Bergensfjord, Nor. S. S	Bergen	do	58 00 N	24 55 W	Jan. 14	9 a., 17	Jan. 17	27.81	SE	SSW, 10	WSW	WSW, 11	SSW-WSW.
East Indian, Am. M. S	Chester	Havre	46 14 N	38 10 W	Jan. 19	1 a., 19	Jan. 19	29.63	S	SW, 10	W	SW, 10	SSW-W.
Ootmarsum, Du. S. S	Barry	Habana	32 42 N	30 58 W	do	9 a., 19	Jan. 20	30.06	N	N, 8	N	N, 9	Steady.
Henri Jasper, Belg. S. S	Antwerp	New York	43 18 N	47 30 W	Jan. 21	6 p., 21	Jan. 22	29.66	W	W, 9	W	W, 9	Do.
Quaker City, Am. S. S	Dundee	Philadelphia	53 34 N	37 40 W	Jan. 22	8 p., 22	Jan. 23	29.96	NE	—, 8	NW	—, 10	
Simaloer, Du. S. S	Oran	Boston	36 08 N	44 10 W	Jan. 23	8 p., 23	Jan. 24	29.53	S	SW, 9	WNW	—, 10	SSW-WSW.
Winnebago, Br. S. S	Manchester	New York	53 45 N	29 54 W	Jan. 22	7 a., 23	Jan. 26	28.84	S	SW, 10	WSW	SW, 10	SW-W.
Shickshinny, Am. S. S	Savannah	Liverpool	45 22 N	41 45 W	Jan. 21	11 p., 24	Jan. 24	29.40	N	N, 8	NW	NE, 10	N-NW.
Bilderdijk, Du. S. S	New York	Rotterdam	49 10 N	31 59 W	Jan. 24	8 p., 25	Jan. 25	29.52	ESE	SSE, 7	SSE	SSE, 9	ESE-SE-SSE.
Steel Navigator, Am. S. S.	Alexandria	New York	33 00 N	58 02 W	Jan. 25	6 a., 26	Jan. 26	29.76	WSW	W, 10	NNW	NW, 11	W-NW.
Simaloer, Du. S. S	Oran	Boston	30 57 N	60 02 W	Jan. 27	11 p., 27	Jan. 29	29.56	SSE	S, —	NNW	—, 11	S-SW.
Queenswood, Br. S. S	Boston	Charleston	33 40 N	77 20 W	Jan. 26	3 a., 27	Jan. 27	30.09	SE	SW, 8	W	SW, 8	S-SW-W.

OCEAN GALES AND STORMS, JANUARY, 1932—Continued

Vessel	Voyage: From—	Voyage: To—	Position at time of lowest barometer: Latitude	Position at time of lowest barometer: Longitude	Gale began	Time of lowest barometer	Gale ended	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Direction and highest force of wind	Shifts of wind near time of lowest barometer
NORTH ATLANTIC OCEAN—Continued													
Gonzenheim, Ger. S. S.	Enden	Portland, Me.	50 07 N	31 10 W	Jan. 25	9 p., 27	do	29.83	SSE	S, 11	WNW	S, 11	S-NW.
Winnebago, Br. S. S.	Manchester	New York	45 56 N	54 48 W	Jan. 28	8 p., 28	Jan. 30	29.32	SE	SW, 5	NW	WNW, 10	SW-WNW.
Emanuel Nobel, Belg. S. S.	Antwerp	Port Arthur	36 04 N	39 13 W	Jan. 27	Noon, 29	Jan. 31	29.81	SSW	SW, 10	NW	—, 10	SW-W-N.
Dakotan, Am. S. S.	Los Angeles	New York	33 35 N	74 21 W	Jan. 30	Noon, 30	Jan. 30		SW	SW, 7	NW	NW, 10	SW-NW.
Savoia, Ital. S. S.	Genoa	Philadelphia	35 00 N	41 00 W	do	4 a., 30	Jan. 31	29.79	WNW	NNW, 9	NW	WNW, 11	
Beemsterdijk, Du. S. S.	Rotterdam	Boston	42 54 N	59 55 W	Jan. 29	2 a., 31	Feb. 1	29.32	WNW	SW, 5	WNW	N, 9	W-WNW.
Lafcomo, Am. S. S.	Seville	Pensacola	28 20 N	32 00 W	Jan. 31	4 p., 31	Feb. 2	29.81	WNW	WNW, 6	NNW	WNW, 8	Steady.
City of Havre, Am. S.S.	Hamburg	Baltimore	37 00 N	65 06 W	do	8 a., 31	Feb. 3	29.43	W	NW, 10	NNW	—, 12	
NORTH PACIFIC OCEAN													
Hakonesan Maru, Jap. M. S.	Yokohama	San Francisco.	42 49 N	161 50 W	Jan. 1	3 p., 1	Jan. 4	29.23	S	SSE, 8	S	SSE, 9	S-SSE.
Kiyo Maru, Jap. S. S.	do	Los Angeles	37 53 N	155 24 E	Jan. 2	2 p., 3	do	29.28	SE	WSW, 9	WNW	W, 11	SE-SW.
Everett, Am. S. S.	Dairen	Seattle	49 47 N	151 27 W	Jan. 4	8 a., 4	do	29.32	NE	NNE, 9	NNW	NNE, 9	NE-NNE.
Golden Sun, Am. S. S.	San Francisco	Yokohama	30 10 N	172 15 W	Jan. 5	2 a., 5	Jan. 5	29.50	WSW	WSW, 7	SW	SW, 9	
Pres. Jefferson, Am. S. S.	Victoria	do	42 00 N	156 00 E	do	10 a., 5	Jan. 6	29.44	NE	WNW, 7	NNW	NW, 10	
Northwestern, Am. S. S.	Seattle	Seward	60 06 N	149 27 W	do	11 a., 5	do	29.40	NW	NW, 9	NW	NW, 10	Steady.
Silverhazel, Br. M. S.	Cebu	San Francisco	33 00 N	174 15 E	do	5 a., 7	Jan. 7	29.55	NW	WNW, 9	NNW	WNW, 9	NW-WNW.
Pres. Cleveland, Am. S. S.	Yokohama	Seattle	45 34 N	179 13 E	Jan. 6	2 a., 7	Jan. 8	29.28	ENE	N, 9	N	N, 9	ENE-N.
Knoxville City, Am. S. S.	Kahului	Balboa	21 13 N	148 00 W	Jan. 8	4 a., 8	do	30.10	E	E, 7	ENE	E, 8	E-ENE.
Menestheus, Br. M. S.	Balboa	San Pedro	13 08 N	94 00 W	Jan 9	4 p., 9	Jan. 10	29.85	NW	N., 7	N	N., 8	NW-N.
San Pedro Maru, Jap. M. S.	Port Costa	Osaka	31 40 N	175 00. E	do		do		N		NE	N., 10	N-NNE-NE.
Hakutatsu Maru, Jap.	Miike	San Pedro	45 18 N	169 30 E	do	8 a., 11	Jan. 12	29.70	S	S., 10	W	S., 10	S-W.
Golden River, Am. S. S.	Portland	Osaka	37 39 N	173 55 W	Jan. 10	3 a., 10	Jan. 10	29.61	WNW	N., 6	N	N., 10	Steady.
Golden Sun, Am. S. S.	San Francisco	Yohohama	30.56 N	178 16 E	do	4 a., 10	Jan. 11	30.00	N	N., 7	NE	NE., 10	
Silverash, Br. M. S.	Ternate	San Pedro	36 12 N	162 28 W	do	4 a., 11	do	30.28	ENE	E., 9	ESE	E., 9	ENE-E.
Silverhazel, Br. M. S.	Cebu	San Francisco	38 54 N	161 15 E	do	9 a., 10	Jan. 12	30.17	NE	NE., 8	ESE	E., 10	NE-ENE-E.
Pres. Cleveland, Am. S. S.	Yokohama	Seattle	49 00 N	128 44 W	do	8 p., 12	Jan. 13	29.62	WNW	N., 7	ESE	N., 10	NW-N-ESE.
Adm. Farragut, Am. S. S	San Francisco	San Diego	34 26 N	120 28 W	Jan. 12	— 13	do	29.72	W	WNW., 7	NW	W., 8	W-WNW.
Diana Dollar, Am. S. S.	Philippines	San Francisco	40 12 N	151 32 E	do	8 a., 13	do	30.03	SW	NW., 3	NW	SW., 9	SW-NW.
Fernmoor, Nor. M. S.	San Pedro	Yokohama	30 50 N	178 55 W	do	4 p., 12	Jan. 14	29.79	NE	NE., 9	N	NNE., 10	NE-N.
Michigan, Am. S. S.	Portland	do	49 19 N	173 20 E	Jan. 13	4 a., 14	do	29.18	SSW	WSW., 5	SW	—, 11	SW-WSW.
Adm. Farragut, Am. S. S	San Francisco	Portland	37 55 N	122 49 W	Jan. 14	7 p., 14	do	29.64	SSW	S., 10	ESE	S., 10	SSW-S-SE.
Adm. Peoples, Am. S. S.	Portland	San Diego	41 10 N	124 34 W	do	2 p., 14	Jan. 15	29.44	SSE	SSE., 9	SE	SSE., 9	SE-SSE.
Golden River, Am. S. S.	do	Osaka	35 06 N	158 00 E	Jan. 17	4 p., 17	Jan. 17	29.81	SSW	WSW., 6	N	—, 9	
Diana Dollar, Am. S. S.	Philippines	San Francisco	46 05 N	175 10 E	do	8 p., 17	Jan. 18	29.51	SE	SSW., 9	W	SSW., 9	S-SW-W.
Tanaha, Br. S. S.	Shanghai	do	41 33 N	175 58 W	Jan. 19	6 a., 20	Jan. 20	29.29	SSE	SSE., —	WNW	SSE., 12	SSE-S.
Golden Dragon, Am. S. S.	Tsingtao	do	38 10 N	164 00 E	do	6 a., 20	do	29.61	SSE	WSW., 7	NNW	NNW., 9	WSW-WNW.
Diana Dollar, Am. S. S.	Osaka	Los Angeles	46 31 N	160 28 W	Jan. 20	4 a., 21	Jan. 21	29.73	S	SSE., 9	W	S., 11	SSE-S-W.
Do	do	do	44 52 N	149 56 W	Jan. 23	6 a., 23	Jan. 23	29.70	NNE	NNW., 9	WNW	WNW., 10	N-NNW.
Victoria, Am. S. S.	Seward	Seattle	58 31 N	138 08 W	Jan. 22	4 a., 22	Jan. 22	29.54	SE	SE 10	SE	SE, 10	Steady.
Tacoma, Am. S. S.	Manila	San Francisco	45 30 N	173 15 E	Jan. 25	Noon, 27	Jan. 28	29.28	N	NW, 10	W	NW, 10	NW-WNW.
Ohioan, Am. S. S.	New York	Los Angeles	15 50 N	95 40 W	Jan. 27	4 p., 27	Jan. 27	29.85	N	NE, 6	NE	NW, 8	NW-NE.
Malayan Prince, Br. M. S.	Los Angeles	Yokohama	30 00 N	157 28 E	do	1 p., 28	Jan. 29	29.55	WSW	WSW, 9	N	W, 10	WSW-W.
Silvermaple, Br. M. S.	Manila	Portland	35 30 N	141 30 E	do	10 p., 27	do	29.78	N	N, 8	NNW	NW, 9	N-NW-NNW.
Soyo Maru, Jap. M. S.	Yokohama	San Francisco	45 02 N	176 55 E	Jan. 28	2 p., 29	do	29.10	SE	SSE, 9	S	SSE, 9	SSE-SW-S.
Northwestern, Am. S. S.	Seward	Seattle	59 04 N	135 10 W	Jan. 30	4 a., 30	Jan. 30	30.54	N	N, 7	N	NW, 10	
Hakubasan Maru, Jap. M.S.	Yokohama	San Francisco	37 40 N	156 35 E	Jan. 31	4 p., 31	Feb. 1	29.17	NNW	NW, 9	WNW	NNW, 10	
SOUTH PACIFIC OCEAN													
Makura, Br. S. S.	Sydney	Wellington	31 27 S	170 15 W	Jan. 27	10a., 28	Jan. 29	28.95	SE	NNE, 11	W	NE, 11	
SOUTH ATLANTIC OCEAN													
Solafric, Br. M. S.	Durban	Rio De La Plata.	31 40 S	39 10 W	Jan. 5	4 p., 5	Jan. 6	29.76	SW	SW, 8	SSE	SW, 9	W-SW-S
MEDITERRANEAN SEA													
Kattegat, Ger. M. S.	Ertvelde	Batum	40 30 N	27 05 E	Jan. 1	2 p., 1	Jan. 1	29.55	SSE	SSE, 11	SSE	SSE, 11	Steady.

NORTH PACIFIC OCEAN

By WILLIS E. HURD

Atmospheric pressure.—The distribution of atmospheric pressure over the North Pacific Ocean for January, 1932, showed on the average a moderate depression—the Aleutian LOW—north of the fiftieth parallel; the crest of an anticyclone extending from the coast of the United States to near midocean; and another and more intense anticyclone extending eastward from the China coast beyond Honshu and the Ogasawara Islands.

As compared with the pressures of the preceding December, the Aleutian LOW had filled in by fully 0.20 inch, and the pressures on the American and Asiatic coasts had risen. At Honolulu barometric conditions were unchanged, but at Midway Island the December HIGH (30.18 inches) had disappeared, and in its stead much lower average pressure (29.94 inches) prevailed.

Pressures were above normal for January at all points along the American coast north of the thirtieth parallel, except southeastern Alaska, with Juneau reading 0.07 inch below normal.

Special attention is called to the addition of several island and coast stations from Asiatic sources to Table 1.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure at sea level, North Pacific Ocean and adjacent waters, January, 1932, at selected stations*

Stations	Average pressure	Departure from normal	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Point Barrow [1] [3]	30.17	+0.09	30.80	5	29.20	12
Dutch Harbor [1]	29.78	+0.20	30.34	[4] 10	28.82	21
St. Paul [1]	29.73	+0.10	30.18	9	29.14	28
Kodiak [1]	29.75	+0.16	30.52	30	28.98	9
Juneau [3]	29.81	−0.07	30.69	30	29.03	5
Tatoosh Island [2] [5]	30.04	+0.06	30.67	22	29.34	12
San Francisco [2] [5]	30.16	+0.05	30.49	17	29.58	31
Mazatlan [1] [3]	29.97	−0.05	30.04	8	29.90	[4] 1
Honolulu [2]	30.01	+0.01	30.15	25	29.80	31
Midway Island [1]	29.94	−0.09	30.30	23	29.40	14
Guam [1]	29.84	−0.06	29.96	20	29.68	[4] 4
Manila [1]	29.95	−0.03	30.08	10	29.86	[4] 3
Naha [1] [3]	30.23	+0.15	30.40	11	30.02	31
Chichishima [1]	30.12	+0.11	30.44	21	29.90	1
Nemuro [1] [3]	29.99	....	30.48	20	29.62	3

[1] Data based on 1 daily observation only, with departures computed from best available normals related to time of observation.
[2] A. m. and p. m. observations.
[3] For 24 to 29 days, with missing dates distributed over the month.
[4] And on other dates.
[5] Corrected to 24-hour mean.

Cyclones and gales.—General cyclonic activity slackened on the North Pacific during January, 1932, as compared with that of the preceding month. The result was a lessened number of stormy days, and of days with gales of the higher wind velocities (11 to 12). Among the many storm reports contributed by seamen, a considerable percentage of the whole showed gales that did not exceed force 8. The month as a whole must be considered fairly stormy, however, and it may be noted that gales were almost as frequent on the central and southern trans-Pacific routes as they were along the northern, which is a rather unusual condition.

The dates of greatest storm intensity, as indicated by reports of maximum-force gales, were those of the 2d–3d, the 13th, and the 20th and 21st. On the 2d–3d a cyclone that had moved eastward from northern Japan intensified until central pressures were about 29 inches, and caused westerly gales of force 11 near 38° N., 155° E. On the 13th, in connection with an energetic cyclone that moved into the Aleutian region from the Okhotsk Sea, a gale of force 11 was experienced south of the western Aleutians. On the 20th and 21st cyclonic conditions, spreading eastward, covered a great area in northern mid-ocean, during the prevalence of which southeasterly gales of force 11–12 were reported near 40° N., 175° W., and 46° N., 160° W., and gales of lesser force over practically the entire extent of the LOW.

Gales of force 9 and 10 were fairly frequent during several intensifications of the Aleutian cyclone. The table of gales, however, sufficiently indicates their distribution.

About January 10th a LOW with a tropical characteristics formed south of Midway Island and spreading rapidly northward, caused fresh north and northeast gales over a considerable stretch of the sea. It early established contact through a long trough with the LOW over the eastern Aleutians, but it continued active in the neighborhood of Midway Island until the 14th, on which day the Midway pressure dropped as low as 29.40 inches. The LOW thereafter receded rapidly northward.

Owing to the strength of the Asiatic HIGH, the northeast monsoon attained the strength of a moderate gale on several days, particularly from the 8th to 11th, between Luzon and the Nansei Islands.

East of the Hawaiian Islands, locally intensified trades which reached the force of a fresh gale, occurred on the 8th and from the 20th to 24th.

Off the California coast fresh to strong gales occurred on the 11th to 14th and on the 19th, during southward incursions of the Aleutian LOW, or westward expansions to the coast of extensive LOWS over the United States.

In the Gulf of Tehuantepec northers of fresh gale force were encountered on the 9th and 27th, and of moderate gale force on the 20th and 21st.

Conditions at Honolulu.—The prevailing wind at Honolulu was from the east, with a maximum velocity of 28 miles from the same direction on the 11th. This January was the warmest there since 1889.

Fog.—From the 3d until the 10th fog formed over a considerably region between 160° west longitude and the American coast, 30° and 50° north latitude, and on a few scattered days thereafter.

Haze.—"Very heavy haze due to volcanic dust from Acatenango and Fuego that settle on the ship and surrounding waters," was reported by the American steamship *Knoxville City*, while in the Gulf of Tehuantepec on the 21st. Similar observances were made by other vessels crossing the gulf on the 22d and 23d.

SEA-SURFACE TEMPERATURE OBSERVATIONS, JANUARY, 1932

By GILES SLOCUM

A change in the general plan of presenting sea-surface temperature data is initiated in this issue of the REVIEW. During the calendar year 1931 the REVIEW carried data for 1930, the material appearing in the issues dated a year after the months in which the observations were made. Hereafter the data will be for the current month and year.

The method of publishing a year late had the advantage of presenting complete or final figures. The new plan requires the omission of the relatively few reports which do not reach the files in time to be included. Final means, embodying all available material will, however, be computed and published after the close of each year in connection with a brief annual summary.

The disadvantage involved in publishing preliminary values subject to later slight revisions is not vital. Preliminary values will be found to vary ordinarily by not more than three-tenths of a degree from the final figures. Continuing discrepancies of this order would doubtless be significant in the areas from which these values are gathered, since the monthly and annual ranges are small, but such differences as will appear between the preliminary and final figures will be in the nature of accidentals and will therefore be of minor importance for purposes other than refined correlation computations, for which the corrected annual summaries should be used.

An exception in the proposed method of publication is made in the case of the 1931 data, which have not yet been presented in any form. To fill the gap between 1930 and 1932, resulting from this change of plan, the data for 1931 are presented in the present issue, summarized for the whole year. The values for December, 1931, necessarily remain provisional but they will be revised as soon as practicable.

A disadvantage of the plan of publishing a year late (followed in 1931) was that the data were then too old to be of interest in connection with current weather. It is primarily to eliminate this disadvantage that the present plan, which will place the figures in the hands of the public within 90 days after the close of each month, is inaugurated.

TABLE 1.—*Preliminary mean sea-surface temperatures (°F.) in the Caribbean Sea and Straits of Florida, January, 1932*

Quarter	Period	Caribbean Sea			Straits of Florida		
		Mean	Departure from 13-year mean (1920-1932)	Change from preceding month	Mean	Departure from 13-year mean (1920-1932)	Change from preceding month
		°F.	°F.	°F.	°F.	°F.	°F.
I		80.0	+0.6		77.3	+2.1	
II		79.5	+0.2		76.0	+1.0	
III		79.6	+0.6		76.7	+1.8	
IV		79.5	+0.8		76.5	+2.0	
	Month	79.6	+0.5	−1.0	76.6	+1.7	−1.8

Table 1 shows the preliminary mean temperatures in the Caribbean Sea and the Straits of Florida for January, 1932.

CARIBBEAN SEA

The Caribbean Sea is defined as the area included between the American Continents on the south and west and the Greater Antilles and outermost Lesser Antilles on the north and east. The Mona Passage, the Windward Channel south of 20° N., and the Yucatan Channel west from Cape San Antonio to the eighty-fifth meridian, north on this meridian to 22° N., west to 87° W., and south to the Yucatan Peninsula, are included.

January, 1932, was a warm month in the Caribbean Sea, being the twenty-third consecutive month with a temperature at or above the 13-year mean (1920–1932).

STRAITS OF FLORIDA

The Straits of Florida data refer to the western part of the Straits area, that bounded on the east by the eightieth meridian, on the north by the twenty-fifth parallel, on the west by the eighty-fourth meridian, and on the south by the Cuban coast.

The month of January, 1932, was the warmest January of record (1920–1932), being 0.8 above the previous warmest which occurred in 1924 and 1925, in both of which years the mean January temperature was 75.8° in the Straits of Florida.

SUMMARY OF SEA-SURFACE TEMPERATURE DATA FOR 1931

By GILES SLOCUM

The data for the Caribbean Sea and the Straits of Florida for 1931 are here summarized, as a whole, for reasons discussed in this issue under the caption, "Sea-Surface Temperature Observations, January, 1932."

In the accompanying table the values for the first 11 months of 1931 are final. Those for December are based on about 97 per cent of the data that is expected to be available. Corrected values for this month will be given later.

CARIBBEAN SEA

The monthly mean temperature of the Caribbean Sea was higher than the average throughout 1931. The means for January, March, April, May, June, July, and August were the highest of record for these months during the 12 years for which adequate data have been collected and analyzed, and so also were their departures from the 12-year means. The previous greatest positive departures, 0.8°, occurred in September and October, 1927, and December, 1930.

May was the most extreme month in 1931. This usually is a midspring month, characterized as it progresses by a rapid rise in temperature in the Caribbean Sea, but not by relatively high temperatures in the course of the annual seasonal march, and it usually is nearly as cool as December, a late autumn month. May, 1931, had a mean temperature of 82.4°, which is 1.8° above the May mean. Since 1920, no other May or June was as warm, and only one July, which was slightly warmer. The average for this month, May, 1931, was indeed higher than is usual for August, the month just preceding the normally warmest of the year. No month in the years 1920 to 1923, inclusive, had a temperature exceeding that of this May.

February, September, and October, 1931, were each once exceeded in temperature by the same respective months in previous years. November and December of this year were not greatly warmer than average.

The surface water of the Caribbean Sea was extremely warm throughout the winter of 1930–31, and the spring rise in temperature, while more rapid than usual, was, by reason of the high temperatures which already prevailed, not different in nature from the rise in other years. The change from the high, but not unprecedented temperature of February, 1931, to the conspicuously extreme anomalous condition in May, took place gradually without remarkable interruptions or accelerations.

The spring temperatures of 1931 were so high that midsummer conditions prevailed for half the year instead of approximately a fourth to a third, as in the usual year. The departures from the mean for the months after May, 1931, were progressively smaller through the summer. While the decrease in magnitude of these departures did not reverse or interrupt the usual seasonal march of progressively warmer months through the summer until the warmest month, September, it did conspicuously flatten the curve representing the march of temperature during the year as compared with that for other years.

By autumn, the extreme thermal abnormality of the spring and early summer months of 1931 had somewhat moderated. Since a diminishing positive anomaly persisted, however, through the fall months, the progression of the temperature curve was much like the normal seasonal march during these final months of the year.

Considering the extreme temperature abnormality of the spring of 1931 from still another angle, that of the relative size of the temperature anomaly in comparison with the annual range, the May, 1931, anomaly was over two-fifths of the mean annual change from winter to summer, which is only 4.3°. The departures for April, June, and July were also conspicuously large, being over a third of the mean annual range.

STRAITS OF FLORIDA

In the Straits of Florida, the first four months of 1931 continued a period, begun in December, 1930, of relatively far subnormal temperatures. Subsequently, the abnormal warmth of the Caribbean Sea appears to have spread into this region. May, June, and November, 1931, were somewhat cooler than the seasonal average; but July, August, September, October, and December were each warmer than their 12-year means—the latter indeed being the warmest December in the period of record. In this respect, the warmth of this month resembled the extreme positive anomalies found in the

Caribbean during the early summer. The year 1931, as a whole, was, however, next to 1920, the coolest thus far found in the Straits area.

While the year as a whole was cool, the temperatures rose with unusual rapidity during the time occupied by the transition from extremely subnormal temperatures in the winter and early spring of 1930–31 to the above-average temperatures which came into evidence in the Straits early in the summer.

GENERAL SUMMARY

The year 1931 in the areas under discussion was probably the most interesting in all respects of any in the term of years covered by the Weather Bureau sea-surface temperature records, the more especially so since it was also an unusual year over continental United States. The extreme conditions briefly described in this summary invite further analysis of the available facts. Treatments of limited phases of such further analysis are in preparation in connection with studies of the entire period from 1919 to the present.

The abnormality of the 1931 sea-surface temperatures in the Caribbean, and to a lesser extent in the Straits, while striking, should, however, still be viewed in proper perspective. The period for which observations have been statistically treated covers only 13 years, and the first year of the 13 is represented by too few observations to be adequately comparable with the other 12. In climatic discussions, this is a short period of time. What is unprecedented in a period of 12 or 13 years of meteorological or oceanographic history of phenomena stands a chance, approaching certainty, of being highly abnormal in a considerably longer period of years, but there is only a small probability that it represents the extreme is such a long period as, say, a century.

Again, the temperature departures from the averages, while proportionately much larger than have been found to have occurred in any other year studied, and while large in relation to the annual range, were yet small in the absolute sense. Temperature ranges and abnormalities of ordinary occurrence in the atmosphere usually run many times greater than the small values of these remarkable abnormalities of 1931 in the Caribbean and Straits of Florida. The range in water temperature in subpolar and temperate seas also generally is much larger than that shown in these tropical and subtropical waters.

Not only is the period of years covered a short one but the geographical area considered is small on the world scale and the statistical analysis thus far made in even this circumscribed area may be inadequate as a true picture of average temperature conditions surrounding the origins of the surface waters of the Gulf Stream.

The significance, or effect, of the abnormalities in relation to the so-called "thermal cargo" of the Gulf Stream is still wide open to further and more rigorous investigation. Some aspects of this problem will be attacked with the data now in hand covering 13 years, but a much longer period of accurate results must be assembled before the problem can be said to have received proper treatment.

TABLE 1.—*Mean sea-surface temperatures (°F.) and number of observations, January to December, 1931*

Month	Caribbean Sea				Straits of Florida			
	Number of observations	Mean	Departure from 12-year mean (1920-1931)	Change from preceding month	Number of observations	Mean	Departure from 12-year mean (1920-1931)	Change from preceding month
		°F.	°F.	°F.		°F.	°F.	°F.
January	550	80.1	+1.1	−1.1	126	73.5	−1.3	−1.4
February	498	79.2	+0.7	−0.9	130	73.6	−0.9	+0.1
March	504	79.6	+0.9	+0.4	132	73.2	−1.6	−0.4
April	526	80.6	+1.2	+1.0	138	75.1	−1.7	+1.9
May	522	82.4	+1.8	+1.8	157	78.4	−0.4	+3.3
June	589	83.0	+1.5	+0.6	154	81.2	−0.3	+2.8
July	604	83.2	+1.4	+0.2	185	83.5	+0.3	+2.3
August	621	83.3	+1.1	+0.1	148	84.4	+0.5	+0.9
September	577	83.4	+0.6	+0.1	158	84.0	+0.5	−0.4
October	586	83.1	+0.5	−0.3	173	81.8	+0.4	−2.2
November	504	81.8	+0.1	−1.3	164	78.5	−0.2	−3.3
December [1]		80.6	+0.2	−1.2		78.4	+1.9	−0.1
Year [1]		81.7	+0.9			78.8	−0.2	

[1] Data incomplete. Figures are preliminary values subject to revision.

CLIMATOLOGICAL TABLES

DESCRIPTION OF TABLES AND CHARTS

Table 1 gives the data ordinarily needed for climatological studies for about 185 Weather Bureau stations making simultaneous observations at 8 a. m. and 8 p. m. daily, seventy-fifth meridian time, and for about 31 others making only one observation. The altitudes of the instruments above ground are also given.

Beginning with January 1, 1932, all wind movements and velocities published herein are corrected to true values by applying to the anemometer readings corrections determined by actual tests in wind tunnels and elsewhere.

Table 2 gives, for about 37 stations of the Canadian Meteorological Service, the means of pressure and temperature, total precipitation, depth of snowfall, and the respective departures from normal values except in the case of snowfall. The sea-level pressures have been computed according to the method described by Prof. F. H. Bigelow in the REVIEW of January, 1902, **30:** 13–16.

CHART I.—*Temperature departures.*—This chart presents the departures of the monthly mean surface temperatures from the monthly normals. The shaded portions of the chart indicate areas of positive departures and unshaded portions indicate areas of negative departures. Generalized lines connect places having approximately equal departures of like sign. This chart of monthly surface temperature departures in the United States was first published in the MONTHLY WEATHER REVIEW for July, 1909, but smaller charts appear in W. B. Bulletin U for 1873 to June, 1909, inclusive.

CHART II.—*Tracks of centers* of ANTICYCLONES; and

CHART III.—*Tracks of centers* of CYCLONES. The Roman numerals show the chronological order of the centers. The figures within the circles show the days of the month, the location indicated being that at 8 a. m., seventy-fifth meridian time. Within each circle is also an entry of the last three figures of (Chart II) the highest barometric reading, or (Chart III) the lowest reading reported at or near the center at that time, in both cases as reduced to sea level and standard gravity. The intermediate 8 p. m. locations are indicated by dots. The inset map of Chart II shows the departure of monthly mean pressure from normal and the inset of Chart III shows the change in mean pressure from the preceding month.

The use of a new base map for Charts II and III began with the January, 1930, issue.

CHART IV.—*Percentage of clear sky between sunrise and sunset.*—The average cloudiness at each regular Weather Bureau station is determined by numerous personal observations between sunrise and sunset. The difference between the observed cloudiness and 100 is assumed to represent the percentage of clear sky, and the values thus obtained are the basis of this chart. The chart does not relate to the nighttime.

CHART V.—*Total precipitation.*—The scales of shading with appropriate lines show the distribution of the monthly precipitation according to reports from both regular and cooperative observers. The inset on this chart shows the departure of the monthly totals from the corresponding normals, as indicated by the reports from the regular stations.

CHART VI.—*Isobars at sea level, average surface temperatures, and prevailing wind directions.*—The pressures have been reduced to sea level and standard gravity by the method described by Prof. Frank H. Bigelow in the REVIEW for January, 1902, **30:** 13–16. The pressures have also been reduced to the mean of the 24 hours by the application of a suitable correction to the mean of 8 a. m. and 8 p. m. readings at stations taking two observations daily, and to the 8 a. m. or the 8 p. m. observation, respectively, at stations taking but a single observation.

The diurnal corrections so applied, except for stations established since 1901, will be found in the Annual Report of the Chief of the Weather Bureau, 1900–1901, volume 2, Table 27, pages 140–164.

The sea-level temperatures are now omitted and average surface temperatures substituted. The isotherms can not be drawn in such detail as might be desired, for data from only the regular Weather Bureau stations are used.

The prevailing wind directions are determined from hourly observations at almost all the stations. A few stations determine their prevailing directions from the daily or twice-daily observations only.

CHART VII.—*Total snowfall.*—This is based on the reports from regular and cooperative observers and shows the depth in inches of the snowfall during the month. In general, the depth is shown by lines connecting places of equal snowfall, but in special cases figures also are given. This chart is published only when the snowfall is sufficiently extensive to justify its preparation. The inset of this chart, when included, shows the depth of snow on the ground at the end of the month.

CHARTS VIII, IX, etc.—*North Atlantic Weather maps of particular days.*

CONDENSED CLIMATOLOGICAL SUMMARY

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course, the number of such records is smaller than the total number of stations.

Condensed climatological summary of temperature and precipitation by sections, January, 1932

Section	Temperature								Precipitation					
	Section average	Departure from the normal	Monthly extremes						Section average	Departure from the normal	Greatest monthly		Least monthly	
			Station	Highest	Date	Station	Lowest	Date			Station	Amount	Station	Amount
	°F	°F		°F			°F		In.	In.		In.		In.
Alabama	53.5	+7.5	Selma	83	15	Valley Head	18	31	7.19	+2.21	Millry	13.87	Union Springs	3.28
Arizona	37.8	−5.4	University of Arizona.	79	19	Alpine	−23	28	0.85	−0.32	Bright Angel Ranger Station.	3.72	8 stations	0.00
Arkansas	46.2	+5.2	Dumas	80	[1] 14	Eureka Springs	11	30	9.67	+5.43	Crossett	16.51	Dutton	3.35
California	41.0	−3.2	Calistoga	81	8	Soda Springs	−24	14	3.14	−1.45	Crescent City	12.03	Imperial	0.00
Colorado	19.7	−4.3	Huerfano	72	18	Hermit	−40	27	0.77	−0.05	Cumbres	5.35	Grover	T.
Florida	66.0	+7.0	Glen St. Mary	89	17	Garniers	27	10	2.30	−0.50	Pensacola	11.90	Venus	0.09
Georgia	55.6	+8.9	Millen	87	14	Clayton	16	31	5.72	+1.51	Clayton	9.75	Brunswick	0.76
Idaho	19.8	−3.1	Glenns Ferry	58	20	2 stations	−35	[1] 25	1.85	−0.31	Roland	6.47	Challis	0.27
Illinois	35.7	+9.0	2 stations	70	14	Freeport	−6	31	3.07	+0.88	Brookport	8.51	Moline	0.95
Indiana	38.4	+10.0	Rome	74	14	2 stations	1	31	5.43	+2.30	Mount Vernon	10.90	Notre Dame	1.67
Iowa	22.5	+4.2	Keokuk	61	28	3 stations	−22	[1] 30	1.81	+0.78	Storm Lake	3.40	Melrose	0.42
Kansas	28.7	−0.8	Independence	67	13	2 stations	−14	30	1.33	+0.71	Columbus	3.25	Goodland	0.18
Kentucky	44.9	+9.3	Williamsburg	80	13	Mount Sterling	14	31	8.17	+3.82	Hopkinsville	12.97	Jenkins	4.40
Louisiana	56.9	+5.6	Lafayette	86	4	Plain Dealing	24	30	10.08	+5.38	Minden	16.59	Port Eads	3.10
Maryland-Delaware	44.7	+11.8	2 stations	80	14	2 stations	13	31	5.04	+1.81	Annapolis, Md.	6.63	Picardy, Md.	2.83
Michigan	31.6	+11.6	Monroe	63	15	Bessemer	−18	30	3.03	+1.15	Whitefish Point	5.66	Howard City	0.88
Minnesota	14.3	+6.6	2 stations	46	12	3 stations	−33	31	1.08	+0.36	Winona	2.93	Mahnomen	0.13
Mississippi	52.7	+5.6	Eupora	83	13	Duck Hill	21	31	10.47	+5.37	Swan Lake	17.82	Boloxi	3.20
Missouri	36.4	+5.9	2 stations	73	14	3 stations	−7	[1] 9	3.32	+1.28	New Madrid	9.92	Edgerton	0.29
Montana	18.1	−0.2	do	65	11	Kinread	−35	30	0.64	−0.24	Heron	4.36	2 stations	T.
Nebraska	20.2	−1.3	Culbertson	60	18	Columbus	−22	30	1.21	+0.66	David City	4.85	do	T.
Nevada	26.5	−4.2	Logandale	70	12	Elko	−29	25	1.32	+0.25	Lewers Ranch	5.19	Thorne	0.00
New England	32.5	+10.0	Waterbury, Conn.	73	14	Van Buren, Me.	−20	26	4.61	+1.20	Somerset, Vt.	8.01	Presque Isle, Me.	1.17
New Jersey	42.4	+12.4	3 stations	76	[1] 14	5 stations	18	[1] 1	4.50	+0.82	Tuckerton	6.09	Newton	2.79
New Mexico	28.8	−4.5	Carlsbad	78	15	Dulce	−35	1	0.88	+0.33	Kingston	3.96	Lovington	T.
New York	34.8	+12.2	2 stations	74	[1] 13	Indian Lake	−9	29	4.28	+1.37	Hoffmeister	7.96	Chazy	1.41
North Carolina	50.4	+9.1	Kinston	86	14	Mount Mitchell	1	31	4.73	+1.04	Highlands	10.23	Manteo	1.82
North Dakota	9.5	+3.3	2 stations	50	[1] 11	Willow City	−34	31	0.55	+0.08	Dunseith	1.60	2 stations	T.
Ohio	39.8	+12.0	McArthur	79	14	4 stations	7	31	5.28	+2.40	Walhonding	7.63	Cleveland	3.46
Oklahoma	40.2	+2.4	2 stations	78	[1] 14	Goodwell	2	26	4.66	+3.16	Smithville	12.70	Kenton	0.66
Oregon	29.9	−1.1	Blitzen	75	16	Seneca	−41	23	3.94	+0.07	Headworks	13.92	Enterprise	0.43
Pennsylvania	40.5	+12.6	2 stations	79	14	Mount Pocono	9	31	4.51	+1.26	Brookville	7.48	Center Hall	1.98
South Carolina	54.5	+8.8	Kingstree	85	14	Walhalla	19	31	4.93	+1.35	Caesars Head	9.82	Charleston	0.98
South Dakota	14.2	−1.3	Spearfish	57	25	Camp Crook	−31	30	0.79	+0.18	Dumont	2.15	Dowling	0.09
Tennessee	46.8	+8.1	2 stations	80	14	Elkmont	12	31	8.32	+3.64	Johnsonville	16.52	Kingsport	4.01
Texas	49.7	+1.5	Riogrande	91	[1] 16	Dalhart	3	6	4.71	+2.89	Madisonville	13.56	Grandfalls	0.00
Utah	18.0	−6.8	St. George	58	8	Woodruff	−35	14	1.33	+0.06	Soldier Summit	5.27	Green River	0.14
Virginia	46.9	+11.1	Kenbridge	82	14	2 stations	15	[1] 10	4.65	+1.46	Pennington Gap	6.96	Winchester	2.23
Washington	28.8	−1.0	4 stations	60	11	Stockdills Ranch	−16	13	5.24	−0.25	Paradise Inn	26.88	Trinidad	0.28
West Virginia	43.4	+11.2	Robertsburg	82	14	Terra Alta	7	31	4.82	+0.94	Horner	6.72	Moorefield	2.33
Wisconsin	23.2	+9.3	Racine	54	[1] 13	Blair	−33	31	1.93	+0.78	Racine	3.62	Weyerhauser	0.98
Wyoming	13.6	−4.9	Torrington	59	19	Riverside	−38	23	0.90	+0.12	Riverside	3.98	Torrington	0.02
Alaska (December)	8.8	+0.8	Dutch Harbor	53	7	Hot Springs	−49	29	2.30	−0.10	Kasaan	10.75	McKinley Park	0.06
Hawaii	70.4	+1.8	Waipahu	90	10	Kanalohuluhulu	38	17	8.87	−0.98	Honomu	45.19	2 stations	0.09
Porto Rico	73.1	0.0	San German	92	12	Guineo Reservoir	40	6	4.60	+1.02	Rio Blanco	12.32	Yauco	0.10

[1] Other dates also.

TABLE 1.—*Climatological data for Weather Bureau stations, January, 1932*

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Departure from normal	Maximum	Date	Mean maximum	Minimum	Date	Mean minimum	Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Departure from normal	Days with 0.01, or more	Wind: Total movement	Prevailing direction	Maximum velocity: Miles per hour	Direction	Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles								0-10	In.	In.
New England							35.3	+10.8										77	4.59	+1.1										7.4		
Eastport	76	67	85	29.98	30.07	+0.07	30.2	+9.8	58	14	38	7	31	23	34	28	24	77	4.16	+0.2	18	9,616	sw.	35	ne.	2	5	4	22	7.8	11.1	0.0
Greenville, Me.	1,070	6		28.86	30.08		22.8		52	14	32	−7	29	14	34				2.50		16	5,668	se.	29		31	4	10	17		15.0	
Portland, Me.	103	82	117	29.97	30.10	+.05	32.6	+10.2	64	14	39	13	5	26	25	29	23	71	6.71	+2.7	17	7,171	n.	29	nw.	15	9	4	18	6.5	17.8	T.
Concord	289	70	79	29.77	30.10	+.05	31.8	+10.2	66	14	40	−1	5	24	41				3.94	+0.9	12	4,654	nw.	25	nw.	31	11	4	16	6.1	15.5	T.
Burlington	403	11	48	29.62	30.08	+.03	29.8	+11.0	60	13	37	5	11	23	28				2.15	+0.4	15	9,705	s.	38	s.	12	1	7	23	8.3	11.3	T.
Northfield	876	12	60	29.13	30.11	+.06	28.2	+13.0	63	13	37	0	4	19	38	25	22	82	2.63	+0.3	16	6,282	s.	25	sw.	13	0	10	21	8.2	13.5	1.7
Boston	125	106	165	29.97	30.11	+.06	38.8	+10.9	69	14	45	18	11	32	23	35	30	73	4.24	+0.6	18	6,696	w.	28	nw.	31	6	8	17	7.2	6.2	0.0
Nantucket	12	14	90	30.09	30.10	+.06	40.3	+9.0	64	14	46	24	11	35	22	38	34	82	6.30	+2.5	16	12,671	w.	57	ne.	10	5	2	24	8.3	T.	0.0
Block Island	26	11	46	30.07	30.10	+.03	40.4	+9.4	59	14	45	23	31	36	18	39	36	83	5.70	+1.9	18	13,150	w.	44	w.	31	4	7	20	7.7	1.4	0.0
Providence	160	215	251	29.94	30.12	+.06	38.6	+11.4	68	14	46	18	11	32	26	35	30	74	4.45	+0.8	16	9,133	nw.	44	nw.	27	7	7	17	6.7	6.9	0.0
Hartford	159	122		29.95	30.14	+.07	37.7	+12.2	70	14	44	18	5	32	27				4.59	+0.6	16		sw.				5	6	20	7.5	2.8	0.0
New Haven	106	74	153	30.01	30.13	+.05	39.6	+11.4	67	14	45	23	31	34	23	37	33	77	5.63	+1.6	16	7,454	n.	33	w.	27	4	9	18	7.4	2.3	0.0
Middle Atlantic States							44.8	+12.5										75	4.24	+1.0										7.3		
Albany	97	107	115	30.02	30.13	+.06	36.0	+12.9	71	13	42	16	11	29	27	33	29	76	2.83	+0.4	14	4,762	s.	27	se.	13	2	10	19	7.9	5.3	T.
Binghamton	871	10	84	29.14	30.10	+.02	37.4	+13.3	69	13	44	18	11	31	28				3.84	+1.4	17	5,544	nw.	25	sw.	13	1	4	26	8.7	2.7	T.
New York	314	414	454	29.78	30.13	+.03	42.8	+11.9	68	14	49	21	31	37	28	39	33	70	4.23	+0.6	16	12,497	nw.	60	nw.	27	6	4	21	7.7	1.0	0.0
Bellefonte	1,050	5	36	28.98	30.12		38.5		70	14	46	15	31	32	29	35	31	78	3.06		16		sw.	37	se.	12	1	7	23	8.4	2.7	0.0
Harrisburg	374	94	104	29.72	30.13	+.03	42.5	+13.5	73	14	49	20	31	36	28	38	33	72	4.00	+0.9	15	6,313	w.	30	w.	27	5	8	18	7.5	T.	0.0
Philadelphia	114	123	367	30.03	30.16	+.05	46.2	+13.6	73	14	52	23	31	40	28	41	36	69	4.60	+1.4	12	10,148	nw.	39	w.	27	5	7	19	7.2	0.7	0.0
Reading	325	81	103	29.79	30.16		43.0	+13.6	71	14	49	18	31	37	24	40	36	77	3.56	0.0	13	6,519	w.	28	w.	27	2	8	21	7.9	T.	0.0
Scranton	805	72	103	29.27	30.15	+.06	39.5	+13.0	69	13	46	19	31	33	27	36	31	74	3.35	+0.3	18	5,655	sw.	31	se.	2	3	9	19	7.8	1.0	0.0
Atlantic City	52	37	172	30.08	30.15	+.04	45.3	+12.8	67	14	51	22	31	40	22	42	38	77	5.13	+1.6	11	13,145	w.	54	e.	1	5	8	18	7.1	1.8	0.0
Cape May	17	13	49				45.2	+11.1	70	15	51	25	31	40	26	42	39	82	4.81	+1.4	10		nw.				2	14	15		~~0.7~~	~~0.0~~
Sandy Hook	22	10	55	30.10	30.12		43.2		66	14	48	23	31	38	24	40	37	79	3.43	−0.5	16	12,148	w.	43	w.	27	4	5	22	7.5	T.	0.0
Trenton	190	159	183	29.94	30.15		43.4	+12.9	73	14	50	20	31	36	29	39	35	75	4.18	+0.9	13	8,869	nw.	42	nw.	27	4	6	21	7.6	0.5	0.0
Baltimore	123	100	215	30.01	30.15	+.03	47.4	+13.6	79	14	54	24	31	40	27	42	37	72	5.85	+2.4	10	8,194	sw.	41	w.	27	5	8	18	7.2	0.8	0.0
Washington	112	62	85	30.03	30.16	+.03	46.8	+13.4	77	15	54	25	31	39	31	41	35	69	4.82	+1.3	12	5,595	nw.	30	nw.	27	7	6	18	7.0	T.	0.0
Cape Henry	18	8	54	30.14	30.16		52.1	+11.9	79	15	60	30	19	44	28	48	43	76	4.39	+1.2	10	9,414	sw.	45	e.	1	7	9	15	6.3	0.0	0.0
Lynchburg	681	153	188	29.43	30.19	+.06	48.2	+10.7	79	14	56	29	20	40	35	42	37	72	4.29	+0.9	12	5,406	w.	37	ne.	1	9	5	17	6.3	0.0	0.0
Norfolk	91	170	205	30.08	30.18	+.05	52.8	+12.2	77	14	61	32	31	45	28	47	43	74	4.53	+1.4	10	10,061	s.	39	w.	27	9	7	15	6.1	0.0	0.0
Richmond	144	11	52	30.02	30.18	+.04	49.8	+11.9	78	14	58	28	31	41	31	45	41	79	5.64	+2.4	12	6,540	sw.	27	sw.	13	8	4	19	6.3	0.6	0.0
Wytheville	2,304	49	55	27.75	30.18	+.04	43.2	+10.2	71	13	52	21	31	34	30	39	34	75	2.77	−0.3	13	5,823	w.	28	w.	27	8	7	16	6.2	T.	0.0
South Atlantic States							55.8	+10.2										78	3.42	−0.1										5.7		
Asheville	2,253	89	104	27.80	30.21	+.06	46.7	+11.3	77	13	56	24	31	37	43	41	37	76	3.99	+0.9	14	7,230	nw.	30	s.	12	10	7	14	5.7	0.0	0.0
Charlotte	779	55	62	29.34	30.19	+.04	51.9	+10.7	71	23	60	28	31	44	31	47	43	77	4.09	+0.1	12	4,856	sw.	25	w.	26	10	4	17	5.9	0.0	0.0
Greensboro	886	6	56	29.22	30.20		47.6		72	22	57	23	20	38	33	43	40	84	4.28		14	6,191	sw.	36	w.	30	9	7	15	6.4	0.0	0.0
Hatteras	11	5	50	30.17	30.18	+.04	56.3	+9.2	72	14	62	38	11	50	26	53	50	83	4.25	−0.2	11	9,872	sw.	35	se.	1	7	12	12	6.2	0.0	0.0
Raleigh	376	103	146	29.78	30.20	+.07	51.8	+10.7	79	14	60	30	31	43	32	47	42	75	4.12	+0.5	13	6,838	sw.	34	nw.	26	10	4	17	6.4	0.0	0.0
Wilmington	72	73	106	30.13	30.22	+.06	57.3	+10.8	78	14	67	33	31	48	33	52	48	79	2.57	−0.7	7	7,273	sw.	38	sw.	30	14	6	11	5.0	0.0	0.0
Charleston	48	11	92	30.16	30.20	+.06	60.0	+10.1	78	14	68	37	31	52	23	54	51	81	0.98	−2.0	7	7,523	sw.	25	ne.	19	13	7	11	4.8	0.0	0.0
Columbia, S. C.	351	41	57	29.82	30.21	+.06	56.0	+10.0	80	14	65	30	31	47	36	50	45	74	3.73	+0.3	9	5,584	sw.	25	sw.	30	11	10	10	5.5	0.0	0.0
Due West	711	10	55	29.43	30.21		52.4		74	20	62	28	31	43	34				5.10		13	6,478	sw.	38	nw.	26	8	7	16	6.4	~~0.0~~	~~0.0~~
Greenville, S. C.	1,039	139	146	29.07	30.19		51.4	+11.1	72	14	59	30	31	44	31	46	41	75	6.82	+2.0	14	6,400	ne.	30	s.	30	11	8	12	5.6	0.0	0.0
Augusta	182	62	77	29.99	30.18	+.02	57.4	+10.4	84	14	67	31	31	48	33	51	47	77	4.91	+1.0	9	3,728	nw.	24	nw.	30	13	8	10	5.0	0.9	0.0
Savannah	65	150	194	30.12	30.19	+.04	60.8	+9.4	80	14	69	35	10	52	29	54	51	80	1.72	−1.1	6	8,744	s.	30	nw.	30	11	9	11	5.4	0.0	0.0
Jacksonville	43	209	245	30.14	30.19	+.04	64.2	+8.8	81	13	72	36	10	57	26	57	54	77	0.40	−2.4	4	8,322	s.	30	sw.	30	4	19	8	5.9	0.0	0.0
Florida Peninsula							71.0	+5.5										78	2.02	−0.4										5.0		
Key West	22	10	64	30.09	30.11	+.01	73.8	+4.3	83	1	78	58	10	69	19	68	65	80	3.57	+1.6	11	8,069	e.	27	n.	9	9	17	5	4.8	0.0	0.0
Miami	25	124	168	30.13	30.16	+.03	71.6	+5.1	82	1	76	43	10	67	24	65	62	74	2.24	−0.3	10	8,898	e.	26	ne.	31	5	18	8	6.0	0.0	0.0
Tampa	35	86	197	30.13	30.17	+.05	67.6	+7.2	82	25	77	41	10	58	29	60	58	80	0.26	−2.4	2	8,873	e.	31	nw.	9	9	13	9	5.3	0.0	0.0
Titusville	44	5		30.14	30.19		67.8		86	30	76	38	10	59	28				1.12		7		se.				15	13	3	3.9	0.0	0.0
East Gulf States							55.4	+7.3										79	6.82	+2.1										6.2		
Atlanta	1,173	190	198	28.94	30.19	+.04	51.2	+8.6	76	13	59	26	10	44	24	47	44	80	4.58	−0.4	13	7,670	nw.	30	nw.	30	6	12	13	6.1	0.0	0.0
Macon	370	78	87	29.80	30.20	+.04	55.9	+9.1	81	14	66	29	31	46	35	49	45	75	6.66	+2.5	8	5,406	nw.	24	s.	13	11	6	14	6.0	0.0	0.0
Thomasville	273	49	103	29.89	30.19	+.03	60.2	+9.2	82	14	70	34	10	51	32	53	50	80	8.49	+4.4	7	6,451	s.	24	sw.	29	8	11	12	5.7	0.0	0.0
Apalachicola	36	11	51	30.13	30.17		61.4		76	18	68	38	31	55	26	57	55	85	5.34	+1.7	6	7,000	e.	27	se.	4	13	5	13	5.2	0.0	0.0
Pensacola	56	149	185	30.10	30.16	+.02	59.0	+6.5	73	17	66	35	31	52	20	55	52	82	11.90	+7.9	9	10,441	e.	41	s.	12	10	7	14	6.1	0.0	0.0
Anniston	741	9	57				51.0	+8.8	78	13	60	24	10	42	27				7.32		11	4,457	s.	21	se.	12	7	9	15		0.0	0.0
Birmingham	700	11	48	29.41	30.19	+.03	51.9	+6.8	78	14	60	27	31	44	27	46	43	77	6.20	+0.7	11	6,462	s.	38	se.	12	7	8	16	6.5	0.0	0.0
Mobile	57	125	161	30.09	30.15	.00	57.5	+6.0	75	15	65	37	31	50	25	53	50	80	4.55	−0.3	13	8,029	n.	34	se.	12	7	8	16	6.5	0.0	0.0
Montgomery	223	100	112	29.94	30.19	+.03	55.3	+7.1	80	14	64	32	31	47	25	50	45	74	5.86	+0.7	12	5,741	s.	25	sw.	29	8	9	14	6.3	0.0	0.0
Corinth	469	6					49.3		77	16	59	24	31	40	32				14.19		14		se.				3	18	10		0.0	0.0
Meridian	375	87	95	29.76	30.16	.00	53.0	+6.0	79	15	62	28	31	44	34	48	44	78	6.19	+0.9	10	5,176	s.	30	sw.	12	7	8	16	6.6	0.0	0.0
Vicksburg	247	65	73	29.86	30.15	.00	54.2	+6.0	78	14	62	33	31	46	36	49	44	75	9.96	+4.6	11	6,463	se.	30	nw.	20	9	4	18	6.4	0.0	0.0
New Orleans	53	76	84	30.07	30.13	.00	60.7	+6.5	81	13	67	40	31	54	30	56	53	81	5.25	+0.9	16	5,848	se.	23	e.	31	8	5	18	6.5	0.0	0.0
West Gulf States							52.7	+4.5										77	6.75	+4.0										6.2		
Shreveport	249	204	220	29.84	30.12	−.02	52.7	+5.7	76	14	61	30	30	45	32	48	43	74	10.51	+6.6	14	7,705	se.	34	nw.	29	13	7	11	5.5	0.0	0.0
Bentonville	1,303	11	44	28.67	30.04	−.10	41.1	+7.0	73	14	50	13	30	32	32				6.53		12	3,979	s.	25	sw.	26	15	5	11		0.0	0.0
Fort Smith	457	79	94	29.60	30.09	−.05	44.5	+5.0	78	14	53	21	30	36	33	39	34	72	5.96	+3.4	13	6,980	e.	35	sw.	26	12	7	12	5.5	0.0	0.0
Little Rock	357	136	153	29.74	30.13	−.02	48.0	+6.6	74	14	56	25	30	40	30	42	36	70	11.38	+6.6	13	6,717	n.	30	se.	12	10	6	15	6.2	T.	0.0
Austin	605	136	148	29.44	30.07		52.9	+3.4	75	13	62	28	30	44	34	48	44	77	6.00	+3.9	14	6,184	n.	26	nw.	4	9	6	16	6.4	0.0	0.0
Brownsville	57	83	100	29.97	30.04		63.8	+4.0	80	16	71	40	9	56	28	59	56	82	1.48	0.0	12	8,945	se.	34	se.	4	2	13	16	7.1	0.0	0.0
Corpus Christi	20	11	78	30.04	30.06	−.04	60.4	+4.4	78	16	67	40	30	54	25	57	54	83	1.13	−0.4	14	8,444	se.	33	se.	4	5	4	22	7.6	0.0	0.0
Dallas	512	220	227	29.53	30.10		48.0		75	14	56	28	30	40	30				7.53	+5.1	10	9,446	se.	35	nw.	29	14	4	13	5.1	0.2	0.0
Fort Worth	670	106	114	29.35	30.08	−.04	48.2	+2.8	76	14	57	29	30	39	27	43	38	72	9.07	+7.0	8	6,682	nw.	25	e.	4	11	7	13	5.7	0.0	0.0
Galveston	54	106	114	30.05	30.11	−.02	58.4	+4.6	72	16	64	40	30	53	24	56	53	85	6.67	+3.3	13	8,682	se.	27	n.	29	7	10	14	6.4	0.0	0.0
Houston	138	292	314	29.95	30.10		57.0	+4.3	79	15	64	34	30	50	28				5.45	+1.8	15	10,096	se.	35	se.	4	7	6	18	6.8	0.0	0.0
Palestine	510	64	72	29.57	30.11	−.01	51.6	+3.4	75	13	61	27	30	42	33	47	43	79	10.90	+7.5	12	6,404	s.	22	nw.	29	13	6	12	5.5	0.0	0.0
Port Arthur	34	58	66	30.04	30.08		58.2		76	15	65	36	30	51	29				7.54	+3.8	11	6,888	e.	24	ne.	31	8	10	13	6.2	0.0	0.0
San Antonio	693	242	301	29.32	30.05	−.05	55.4	+3.1	77	15	64	33	30	46	29	50	46	74	3.30	+1.8	15	8,767	n.	37	nw.	4	8	8	15	6.3	0.0	0.0
Taylor	571	38	51	29.50	30.11	.00	51.6	+4.1	76	13	61	29	30	42	34				7.54	+5.6	14	6,412	n.	24	s.	4	10	8	13	5.8	0.0	0.0

TABLE 1.—*Climatological data for Weather Bureau stations, January, 1932*—Continued

District and station	Elevation of instruments: Barometer above sea level	Thermometer above ground	Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Sea level, reduced to mean of 24 hours	Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Departure from normal	Maximum	Date	Mean maximum	Minimum	Date	Mean minimum	Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Departure from normal	Days with 0.01, or more	Wind: Total movement	Prevailing direction	Maximum velocity: Miles per hour	Direction	Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	° F.	° F.	° F.		° F.	° F.		° F.	° F.	° F.	° F.	%	In.	In.		Miles								0-10	In.	In.
Ohio Valley and Tennessee							**43.6**	**+10.0**										**77**	**5.93**	**+2.2**										**6.9**		
Chattanooga	762	190	215	29.34	30.17	+0.01	49.4	+8.2	73	14	57	26	10	42	28	45	41	78	6.29	+1.0	11	6,244	se.	30	sw.	20	9	7	15	6.2	0.0	0.0
Knoxville	995	102	111	29.10	30.18	+.03	48.4	+9.6	74	14	57	25	31	40	35	44	40	76	5.37	+0.7	14	5,216	sw.	32	sw.	12	8	7	16	6.1	0.0	0.0
Memphis	399	78	86	29.71	30.14	−.02	48.5	+7.6	75	14	56	25	30	41	33	44	39	73	11.87	+7.1	13	5,753	e.	32	sw.	12	11	5	15	5.9	0.0	0.0
Nashville	546	168	191	29.58	30.18	+.02	46.4	+7.8	71	14	55	26	30	38	35	43	39	78	7.74	+3.0	11	7,597	s.	34	se.	12	9	6	16	6.3	T.	0.0
Lexington	989	193	230	29.09	30.19	+.06	42.8	+9.9	68	14	51	17	31	35	30				8.46	+4.3	14	10,506	sw.	47	w.	26	6	10	15	6.7	0.1	0.0
Louisville	525	188	234	29.56	30.16	+.02	43.3	+8.9	69	14	51	18	31	36	29	40	35	75	6.54	+2.5	14	8,046	s.	43	nw.	29	5	9	17	6.8	T.	0.0
Evansville	431	76	116	29.66	30.14	.00	43.3	+9.8	68	14	51	19	31	36	30	39	35	77	7.76	+4.0	14	7,443	s.	49	sw.	12	10	4	17	6.2	T.	T.
Indianapolis	822	194	230	29.21	30.12	.00	38.8	+10.4	66	15	46	12	31	32	34	35	31	76	6.10	+3.2	15	8,669	s.	41	sw.	12	4	10	17	7.3	0.2	0.0
Royal Center	736	11	55	29.27	30.09		35.4		65	15	42	5	31	29	33				2.77	+0.5	13	8,364	w.	34	sw.	12	3	6	22	8.0	0.7	0.0
Terre Haute	575	96	129	29.48	30.12		39.4		67	15	46	12	31	32	33	36	32	81	4.15	+1.4	12	7,724	s.	47	s.	12	5	6	20	7.6	T.	0.0
Cincinnati	627	11	51	29.45	30.15	+.03	41.4	+11.1	68	14	49	14	31	34	28	38	34	79	4.73	+1.2	13	6,547	sw.	30	sw.	26	7	7	17	7.0	T.	0.0
Columbus	822	216	230	29.24	30.14	+.03	40.3	+11.7	70	14	47	14	31	34	25	37	33	79	4.38	+1.3	16	9,366	sw.	41	s.	13	6	6	19	7.0	T.	0.0
Dayton	899	137	173	29.15	30.13		40.4	+10.9	68	14	47	13	31	34	28	37	34	80	6.14	+2.9	14	7,509	sw.	41	sw.	13	6	8	17	7.3	T.	0.0
Elkins	1,947	59	67	28.08	30.19	+.07	42.2	+11.8	72	14	51	16	31	33	38	38	34	79	3.95	+0.2	17	5,618	w.	40	w.	27	5	5	21	7.4	0.1	0.0
Parkersburg	637	77	82	29.50	30.17	+.05	43.9	+11.4	73	14	52	20	31	36	31	39	35	75	4.20	+0.6	15	5,443	se.	28	nw.	29	9	5	17	6.2	T.	0.0
Pittsburgh	842	353	410	29.22	30.14	+.03	41.8	+11.1	70	14	48	15	31	35	28	37	32	71	4.80	+1.8	16	7,491	w.	37	w.	27	4	7	20	7.8	T.	0.0
Lower Lake Region							**37.0**	**+12.5**										**80**	**4.04**	**+1.5**										**8.4**		
Buffalo	767	243	280	29.21	30.06	−.01	37.2	+12.6	61	13	42	11	31	32	27	34	31	82	4.97	+1.7	18	14,079	w.	56	w.	27	2	4	25	8.6	6.1	T.
Canton	448	10	61	29.57	30.06		28.9	+12.6	59	13	36	−4	4	21	36				3.68	+1.2	17	8,253	sw.	33	w.	13	1	8	22	8.3	12.7	T.
Ithaca	836	74	100	29.17	30.10		37.4	+13.1	67	13	44	16	11	31	30	34	30	77	2.00	−0.2	14	8,886	se.	34	nw.	15	1	3	27	8.9	3.7	T.
Oswego	335	71	85	29.70	30.08	+.01	35.7	+11.8	63	13	42	12	11	30	27	33	29	76	4.50	+1.6	19	9,506	s.	34	w.	31	0	2	29	9.3	15.0	7.2
Rochester	523	86	102	29.50	30.09	+.02	37.4	+12.8	64	14	43	14	31	32	30	34	30	75	3.75	+0.9	20	7,245	w.	34	w.	13	2	3	26	8.9	6.3	0.3
Syracuse	596	65	79	29.43	30.09	+.02	37.2	+14.2	68	13	44	12	11	31	28				3.67	+0.6	17	6,636	w.	24	w.	31	1	10	20	8.2	7.5	1.5
Erie	714	130	166	29.29	30.08	.00	39.6	+12.8	65	14	45	14	31	34	28	36	33	77	4.37	+1.6	21	12,072	w.	44	w.	27	3	5	23	8.4	0.8	T.
Cleveland	762	267	337	29.24	30.08	−.01	40.2	+13.7	70	14	47	12	31	34	32	36	31	75	3.46	+1.0	17	11,607	s.	50	s.	13	2	6	23	8.5	0.5	0.4
Sandusky	629	5	67	29.39	30.09	.00	39.0	+12.7	69	14	46	13	31	33	30				4.07	+1.8	17	8,331	sw.	32	sw.	13	2	8	21	8.2	T.	0.0
Toledo	628	208	243	29.39	30.09	.00	37.8	+12.0	63	14	44	12	31	32	26	35	32	80	5.17	+3.0	16	10,798	w.	47	sw.	13	3	7	21	7.6	0.6	T.
Fort Wayne	856	100	119	29.14	30.09		36.8	+9.9	64	15	43	7	31	31	30	34	32	88	3.84	+1.5	13	8,378	sw.	31	s.	12	3	7	21	7.8	0.8	0.0
Detroit	730	218	258	29.27	30.08	.00	36.7	+12.3	59	15	42	6	31	32	23	34	32	86	5.02	+3.0	15	9,008	sw.	41	sw.	13	3	3	25	8.6	0.9	0.0
Upper Lake Region							**29.5**	**+10.7**										**84**	**2.66**	**+0.7**										**8.4**		
Alpena	609	13	89	29.33	30.02	−.02	31.6	+12.5	52	13	36	9	31	27	23	29	26	82	2.67	+0.8	18	9,343	sw.	34	se.	17	0	4	27	8.9	10.8	0.5
Escanaba	612	54	60	29.32	30.01	−.04	26.1	+10.7	43	13	32	−9	31	20	23	25	22	84	2.93	+1.4	16	7,343	sw.	27	s.	11	6	4	21	7.5	19.9	3.5
Grand Haven	632	54	89	29.34	30.04	−.03	33.5	+9.2	53	13	38	6	31	29	26	32	30	87	3.05	+0.6	17	9,468	w.	32	sw.	6	2	1	28	9.2	3.2	1.7
Grand Rapids	707	70	244	29.25	30.04	−.02	34.2	+9.7	58	13	39	5	31	30	25	32	29	81	3.07	+0.7	16	9,518	w.	40	sw.	6	2	1	28	9.0	3.1	2.0
Houghton	668	64	99	29.23	29.98	−.07	25.0	+10.3	47	12	30	3	30	20	21				2.90	+0.5	21	7,385	w.	31	w.	13	3	3	25	8.8	27.7	11.2
Lansing	878	6	88	29.08	30.04		33.8	+11.4	55	13	39	4	31	29	25	32	31	92	2.86	+1.0	17	8,106	sw.	30	sw.	30	1	5	25	8.9	0.6	0.1
Ludington	637	60	66	29.31	30.02		32.2	+9.1	50	13	37	3	30	28	27	31	28	85	2.35	+0.2	20	9,152	w.	35	s.	24	3	0	28	8.9	4.7	1.3
Marquette	734	77	111	29.16	29.98	−.06	27.4	+11.1	47	13	33	−4	30	22	21	25	22	81	2.86	+0.5	18	7,569	w.	32	s.	11	0	4	27	9.1	22.9	2.5
Port Huron	638	70	120	29.34	30.05	−.01	35.2	+12.9	56	13	40	6	31	30	22	33	30	84	3.38	+1.6	19	9,067	w.	34	w.	30	3	5	23	8.5	1.6	T.
Sault Sainte Marie	614	11	52	29.29	30.01	−.02	27.1	+13.8	46	13	32	0	31	22	27	26	24	86	3.79	+1.8	26	7,523	se.	29	nw.	27	1	7	23	8.4	23.6	9.5
Chicago	673	7	131	29.33	30.08	−.02	33.6	+9.9	58	13	39	1	31	28	33	31	28	80	2.20	+0.3	13	8,486	w.	30	sw.	6	7	3	21	7.4	1.9	0.0
Green Bay	617	109	141	29.33	30.02	−.04	25.7	+10.0	46	13	32	−11	31	20	30	24	21	82	2.15	+0.6	17	8,038	sw.	30	s.	12	4	7	20	7.8	12.3	0.7
Milwaukee	681	125	221	29.28	30.04	−.04	30.4	+9.8	52	13	36	−6	31	25	32	28	26	82	1.65	−0.1	10	10,045	w.	35	sw.	6	5	6	20	7.6	7.4	T.
Duluth	1,133	5	47	28.72	30.00	−.09	17.4	+9.5	40	12	24	−23	31	10	36	16	14	84	1.31	+0.3	11	9,823	sw.	43	nw.	29	6	4	21	7.6	14.5	3.7
North Dakota							**9.8**	**+4.8**										**86**	**0.38**	**−0.2**										**6.0**		
Moorhead	940	50	58	28.99	30.06	−.08	11.4	+7.6	35	12	20	−21	31	3	33	11	9	91	0.32	−0.4	6	6,512	s.	21	s.	11	5	8	18	7.5	5.4	4.3
Bismarck	1,674	8	57	28.18	30.07	−.06	9.8	+2.0	43	25	20	−22	30	0	36	8	5	82	0.35	−0.1	6	5,835	nw.	30	nw.	13	12	8	11	5.1	4.7	3.8
Devils Lake	1,478	11	44	28.39	30.05	−.07	7.4	+5.6	39	12	16	−28	30	−2	33	7	5	91	0.35	−0.1	6	7,226	nw.	31	n.	12	9	9	13	6.2	4.6	3.4
Ellendale	1,457	10	56	28.48	30.05		8.0		34	12	17	−23	30	−1	31				0.28	−0.2	8	9,889	nw.	38	n.	13	8	4	19	6.9	8.4	11.5
Grand Forks	833	12	67				9.4		35	12	18	−24	31	1	29	9			0.34		3		nw.	38	se.	11	8	7	16		5.4	9.2
Williston	1,878	41	48	27.98	30.06	−.05	10.6	+4.2	43	11	20	−24	30	2	42	8	5	81	0.59	0.0	4	5,470	sw.	28	n.	12	15	7	9	4.5	6.3	5.4
Upper Mississippi Valley							**29.0**	**+7.6**										**83**	**2.16**	**+0.6**										**7.4**		
Minneapolis	918	102	208	29.01	30.04		18.1	+5.4	42	12	25	−17	31	11	33				1.70	+0.8	11	7,816	w.	27	nw.	29	4	7	20	7.8	18.7	5.0
St. Paul	837	114	149	29.09	30.03	−.08	18.0	+5.4	41	12	26	−16	31	10	36				1.94	+1.0	13	6,851	sw.	29	sw.	11	5	5	21	7.6	22.6	4.0
La Crosse	714	11	48	29.25	30.05	−.06	22.6	+6.5	44	12	30	−13	31	15	37	21	19	87	2.26	+1.2	16	4,357	w.	18	s.	11	5	2	24	7.9	18.9	2.0
Madison	974	70	78	28.96	30.05	−.05	25.9	+9.2	46	13	32	−10	31	20	34	25	23	88	1.04	−0.3	12	6,597	w.	27	s.	19	5	5	21	7.7	3.9	T.
Wausau	1,247	4	62	28.63	30.02		21.3		40	13	28	−19	31	15	35				1.92	+0.7	19	5,026	w.	21	e.	16	4	1	26	8.5	17.9	5.0
Charles City	1,015	10	51	28.96	30.08	−.06	19.4	+5.7	40	25	27	−15	31	12	40	19	17	86	2.37	+1.3	11	5,680	w.	20	nw.	20	6	5	20	7.1	16.5	2.7
Davenport	606	118	143	29.40	30.08	−.04	30.0	+8.2	56	28	36	−4	30	24	32	28	24	78	1.05	−0.4	8	8,508	w.	30	sw.	19	8	2	21	7.3	0.8	T.
Des Moines	861	5	99	29.15	30.09	−.05	24.5	+4.4	51	20	32	−8	30	17	37	23	20	84	1.85	+0.8	10	7,193	nw.	25	nw.	29	7	6	18	6.8	11.2	0.4
Dubuque	700	81	96	29.29	30.07	−.05	26.5	+7.4	46	25	33	−8	31	20	38	25	22	84	1.21	−0.1	8	5,254	nw.	20	s.	19	7	4	20	7.1	3.1	T.
Keokuk	614	64	78	29.41	30.11	−.03	32.7	+7.8	61	28	39	−1	30	26	30	30	26	77	1.28	−0.3	9	6,451	sw.	24	w.	17	6	1	24	7.4	1.7	0.0
Cairo	358	87	93	29.73	30.13	−.03	44.1	+9.2	68	14	52	20	30	37	29	40	37	81	7.02	+3.3	13	6,980	s.	35	sw.	12	8	4	19	6.8	0.9	T.
Peoria	609	11	45	29.42	30.11	−.01	33.2	+10.1	60	13	40	1	30	26	36	30	28	83	2.51	+0.7	9	6,222	w.	20	w.	6	6	6	19	7.3	1.6	0.0
Springfield, Ill.	636	5	191	29.40	30.09	−.04	36.0	+9.5	60	13	42	6	30	30	32	33	30	84	2.16	+0.1	11	8,699	s.	25	w.	6	5	7	19	7.5	0.2	0.0
Hannibal	534	74	109	29.51	30.11	−.02	35.5	+8.4	63	13	42	5	30	29	30				1.53	−0.2	10	7,047	sw.	24	w.	6	5	6	20	7.5	0.2	0.0
St. Louis	568	265	303	29.48	30.10	−.04	39.8	+9.0	68	13	47	13	30	32	31	35	31	76	2.50	+0.2	12	9,186	s.	31	se.	12	9	5	17	6.5	0.1	0.0
Missouri Valley							**24.2**	**+1.4**										**82**	**1.45**	**+0.4**										**6.3**		
Columbia, Mo.	784	6	84	29.24	30.10	−.03	36.2	+7.0	64	20	43	5	30	29	26				1.79	−0.1	12	6,722	w.	21	sw.	20	5	8	18	7.1	T.	0.0
Kansas City	963	161	181	29.04	30.11	−.04	32.8	+4.6	60	20	40	4	30	26	24	30	26	78	1.12	−0.1	11	7,603	sw.	26	sw.	16	6	13	12	6.1	2.4	0.0
St. Joseph	967	11	49	29.02	30.09		29.0		58	20	36	−3	30	22	27	26	24	84	1.30	+0.2	7	6,771	nw.	29	nw.	29	10	7	14	6.2	3.5	0.0
Springfield, Mo.	1,324	98	104	28.64	30.08	−.06	38.8	+5.3	71	14	47	9	30	30	34	35	30	75	3.79	+1.4	11	8,246	s.	31	se.	11	10	11	10	5.2	T.	0.0
Iola	984	11	50	29.00	30.09	−.05	34.5	+4.7	64	13	43	6	30	26	34				1.67	+0.4	11	5,579	s.	21	s.	19	12	5	14	5.7	0.1	0.0
Topeka	987	92	107				30.3	+2.7	60	20	38	2	30	23	27				0.88	−0.1	8	6,915	nw.	24	sw.	19	7	9	15	6.2	1.4	0.0
Lincoln	1,189	11	81	28.79	30.12	−.03	20.2	−2.6	42	12	28	−9	30	13	32	19	17	84	1.92	+1.3	7	6,884	nw.	27	nw.	29	7	9	15	6.5	14.5	4.0
Omaha	1,105	115	122	28.88	30.12	−.03	21.2	−0.7	43	19	28	−9	30	14	27	20	18	86	2.80	+2.1	9	6,328	nw.	25	nw.	29	8	4	19	6.8	25.4	7.3
Valentine	2,598	47	54	27.27	30.12	.00	17.0	−1.9	42	19	26	−10	30	9	31	15	13	88	0.15	−0.3	7	6,260	w.	26	sw.	11	7	10	14	6.1	1.7	2.4
Sioux City	1,135	94	164	28.82	30.10	−.05	17.0	−0.8	39	12	24	−12	30	10	28	16	13	86	1.91	+1.2	9	8,104	nw.	34	nw.	29	6	8	17	7.1	21.9	6.0
Huron	1,306	59	74	28.63	30.11	−.05	11.5	+0.2	37	12	20	−20	30	3	33	11	8	84	0.39	−0.2	9	6,871	nw.	27	nw.	28	12	6	13	5.5	6.1	7.5
Pierre	1,572	70	75	28.35	30.10	−.03	14.6	−1.4	42	11	24	−15	30	6	30	13	7	71	0.17	−0.3	6	6,026	nw.	32	nw.	12	10	8	13	5.7	2.5	1.5
Yankton	1,233	49	57	28.73	30.11	−.05	16.7	−0.6	41	19	24	−13	30	9	29				0.93	+0.3	6	6,007	nw.	27	nw.	29	7	4	20	7.1	12.0	4.0

TABLE 1.—*Climatological data for Weather Bureau stations, January, 1932*—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	° F.	° F.	° F.		° F.	° F.		° F.	° F.	° F.	° F.	%	In.	In.		Miles								0–10	In.	In.
Northern Slope							18.1	−1.2										77	0.70	−0.1										6.0		
Billings	3,140	5	----	----	----	----	20.8	----	54	11	32	−21	14	10	51	----	----	----	0.74	----	6	----	nw.	----	----	----	15	7	9	----	9.9	----
Havre	2,505	11	67	27.32	30.06	−0.04	18.4	+5.5	52	11	28	−20	31	8	37	16	12	80	0.20	−0.5	6	7,964	sw.	35	sw.	25	8	12	11	5.7	3.9	0.1
Helena	4,124	89	113	25.74	30.09	−.06	20.6	+0.4	56	11	28	−22	31	13	32	18	12	66	0.57	−0.3	5	6,119	sw.	54	sw.	11	3	7	21	7.4	10.9	2.0
Kalispell	2,973	48	56	26.93	30.12	.00	19.7	−0.7	48	11	26	−10	31	13	31	18	17	88	1.18	−0.4	16	3,809	nw.	24	sw.	11	0	9	22	8.6	15.5	12.0
Miles City	2,371	48	55	27.46	30.13	+.01	15.2	+0.7	48	11	25	−20	14	5	43	13	10	84	0.76	+0.1	7	3,946	s.	27	nw.	6	9	13	9	5.5	6.6	6.7
Rapid City	3,259	50	58	26.53	30.11	+.01	21.8	−0.2	53	25	32	−14	30	11	43	18	13	75	0.51	+0.1	8	5,185	w.	24	nw.	22	13	5	13	5.5	5.2	1.5
Cheyenne	6,088	84	101	23.86	30.07	+.02	21.4	−4.1	52	12	32	− 2	13	11	48	17	9	63	0.31	−0.1	5	10,013	w.	46	w.	17	12	12	7	4.6	4.1	T.
Lander	5,372	60	68	24.55	30.19	+.07	9.6	−8.7	50	11	22	−28	14	−2	44	7	5	89	0.93	+0.4	9	2,680	sw.	24	sw.	12	14	9	8	4.3	11.4	8.6
Sheridan	3,790	10	47	26.03	30.11	----	15.2	----	58	11	29	−25	30	1	51	12	7	71	1.31	+0.5	13	3,827	nw.	30	nw.	6	9	11	11	5.5	15.4	8.0
Yellowstone Park	6,241	11	48	23.78	30.17	+.03	13.7	−3.9	35	19	22	−15	31	5	38	12	8	76	0.83	−0.8	16	6,081	s.	30	sw.	11	4	8	19	7.5	20.2	20.8
North Platte	2,821	11	51	27.05	30.10	−.02	22.8	−0.1	56	19	32	− 8	30	14	31	20	17	81	0.41	0.0	7	5,404	w.	27	n.	5	9	9	13	5.8	4.7	2.6
Middle Slope							29.6	−0.8										74	1.66	+1.0										5.1		
Denver	5,292	106	113	24.62	30.04	−.01	27.8	−2.0	61	12	38	6	30	18	38	22	11	53	0.53	+0.1	7	5,865	s.	28	w.	28	15	8	8	4.7	9.2	0.2
Pueblo	4,685	80	86	25.21	30.03	−.02	28.2	−1.7	71	19	42	0	30	14	50	23	14	58	0.52	+0.2	7	5,543	nw.	37	w.	12	15	11	5	4.3	6.4	1.0
Concordia	1,392	50	58	28.60	30.14	.00	23.4	−3.0	48	19	30	−2	30	16	25	22	20	90	1.24	+0.6	7	6,036	w.	23	n.	5	10	9	12	5.4	12.1	1.5
Dodge City	2,509	88	100	27.42	30.12	+.01	26.8	−2.7	49	19	34	0	31	18	29	24	22	86	1.28	+0.9	8	8,505	nw.	35	ne.	5	13	8	10	4.9	12.5	T.
Wichita	1,358	139	158	28.61	30.09	−.04	32.4	+1.1	57	20	40	5	30	25	26	29	25	79	1.49	+0.7	10	8,277	s.	35	s.	19	11	4	16	5.8	4.5	T.
Oklahoma City	1,214	10	47	28.76	30.08	−.03	39.8	+3.4	69	13	48	17	30	31	30	35	31	77	4.92	+3.7	11	7,705	s.	24	w.	26	12	6	13	5.5	T.	0.0
Southern Slope							43.1	+0.4										66	1.06	+0.4										4.8		
Abilene	1,738	10	52	28.24	30.08	−.01	45.3	+1.1	75	13	56	25	24	35	34	39	33	70	1.68	+0.7	7	7,446	s.	28	s.	31	12	7	12	5.5	T.	0.0
Amarillo	3,676	10	49	26.24	30.06	.00	35.2	−0.1	62	19	45	13	6	25	35	29	24	71	1.60	+1.1	4	7,039	sw.	33	sw.	12	12	11	8	4.7	15.9	0.0
Big Spring	2,537	5	62	----	----	----	43.2	----	73	28	55	22	30	32	39	----	----	----	0.98	----	3	----	s.	----	----	----	12	14	5	----	T.	0.0
Del Rio	944	64	71	29.02	30.02	−.04	53.3	+1.0	76	28	64	26	30	43	44	46	39	65	0.32	−0.2	8	6,349	se.	31	n.	29	12	7	12	5.3	0.0	0.0
Roswell	3,566	75	85	26.36	30.05	+.01	38.8	−0.5	69	20	52	16	8	26	41	31	21	57	0.65	+0.1	2	5,770	s.	37	sw.	28	16	10	5	3.9	2.8	0.0
Southern Plateau							36.8	−3.9										57	0.32	−0.3										3.2		
El Paso	3,778	152	175	26.19	30.04	+.03	42.8	−2.2	70	19	55	20	30	31	38	34	22	47	0.17	−0.3	2	7,791	nw.	39	w.	12	18	6	7	3.5	0.3	0.0
Albuquerque	4,972	51	66	25.03	30.08	----	29.4	----	56	20	41	5	7	18	35	24	16	62	0.45	----	5	4,153	ne.	33	se.	23	16	6	9	4.4	4.4	0.0
Santa Fe	7,013	38	53	23.14	30.09	+.05	22.9	−5.9	46	20	33	0	26	13	31	19	13	68	0.93	+0.3	10	4,018	n.	19	n.	6	15	8	8	4.6	15.0	1.2
Flagstaff	6,907	10	59	23.25	30.03	−.02	19.8	−6.9	49	9	34	−12	29	5	42	18	----	82	1.24	----	7	6,610	nw.	32	sw.	12	12	11	8	----	14.2	4.0
Phoenix	1,108	10	107	28.88	30.06	+.03	47.0	−4.2	73	19	60	27	26	34	36	38	25	48	0.10	−0.7	1	4,137	e.	23	n.	23	25	2	4	1.9	0.0	0.0
Yuma	141	9	54	29.95	30.10	+.05	50.8	−3.6	71	12	63	26	25	38	34	40	24	37	T.	−0.4	0	5,213	n.	34	n.	10	25	6	0	1.5	0.0	0.0
Independence	3,957	6	27	26.00	30.11	+.04	37.4	−0.8	63	7	49	8	16	26	35	29	----	----	0.42	−0.5	4	----	nw.	----	----	----	19	4	8	----	5.0	0.0
Middle Plateau							23.0	−5.2										77	1.00	−0.1										6.0		
Reno	4,532	74	81	25.49	30.16	+.03	29.8	−2.7	60	11	39	−2	14	20	31	26	21	69	1.56	0.0	9	5,039	w.	32	sw.	11	10	7	14	5.4	15.9	3.5
Tonopah	6,090	12	20	----	----	----	23.2	----	47	11	29	3	23	17	19	20	16	71	0.15	----	3	----	se.									
Winnemucca	4,344	18	56	25.67	30.21	+.05	23.4	−5.2	54	11	34	−6	25	13	30	21	19	84	1.43	+0.4	12	6,072	sw.	31	sw.	11	6	7	18	6.6	13.3	8.8
Modena	5,473	10	43	24.60	30.15	+.05	16.2	−10.5	43	9	29	−12	24	3	36	15	12	82	0.41	−0.4	6	6,477	nw.	31	sw.	12	12	8	11	5.4	10.8	6.0
Salt Lake City	4,360	163	203	25.65	30.16	+.01	23.9	−5.3	45	12	30	1	26	18	30	22	18	75	1.27	0.0	14	4,474	nw.	30	s.	11	5	9	17	6.9	18.7	9.8
Grand Junction	4,602	60	68	25.39	30.09	+.03	21.8	−2.2	44	12	31	−1	26	12	28	18	15	80	0.31	−0.3	7	3,638	nw.	28	sw.	12	9	13	9	5.5	3.7	1.0
Northern Plateau							26.5	−2.0										81	1.38	−0.2										7.9		
Baker	3,471	48	53	26.49	30.20	+.04	20.7	−4.2	45	9	29	−4	25	13	24	19	15	76	1.35	0.0	17	4,900	se.	21	se.	11	4	6	21	7.7	11.8	12.5
Boise	2,739	79	87	27.26	30.22	+.03	27.2	−2.6	51	11	34	7	25	21	21	25	21	78	1.09	−0.6	14	4,379	se.	21	se.	31	6	5	20	7.3	8.9	0.0
Lewiston	757	40	48	29.35	30.14	−.02	33.0	+0.5	56	11	38	15	31	28	21	----	----	----	0.97	−0.5	12	3,611	e.	19	w.	11	2	5	24	8.3	4.6	1.3
Pocatello	4,477	60	68	25.49	30.19	−.01	19.3	−5.4	40	18	26	−9	25	12	23	19	17	87	1.97	+0.6	18	6,989	se.	38	sw.	27	3	6	22	7.7	27.4	14.5
Spokane	1,929	101	110	28.01	30.13	+.01	26.1	−1.4	46	11	31	2	29	21	21	25	23	88	1.99	−0.2	16	4,423	s.	26	sw.	11	2	4	25	8.8	20.4	10.8
Walla Walla	991	57	65	29.03	30.14	−.01	33.1	+0.4	60	11	39	14	31	27	27	31	27	78	1.51	−0.4	13	3,849	s.	30	w.	11	2	7	22	8.3	8.3	4.3
Yakima	1,076	58	67	28.95	30.15	----	26.3	−1.1	60	11	35	8	24	18	35	24	20	77	0.76	−0.5	7	2,920	nw.	31	sw.	11	4	8	19	7.5	8.0	7.6
North Pacific Coast Region							39.6	−0.8										86	5.62	−0.8										8.4		
North Head	211	11	56	29.86	30.10	+.05	40.8	−1.3	52	23	44	23	31	37	18	39	37	88	8.37	−0.4	24	11,673	se.	56	s.	26	2	6	23	8.5	3.0	T.
Port Angeles	29	8	53	----	30.10	----	37.6	----	52	11	42	19	31	33	18	----	----	----	4.05	−0.5	22	5,515	s.	32	w.	11	1	10	20	----	14.7	6.5
Seattle	125	215	250	29.94	30.08	+.03	38.8	−0.7	52	11	43	22	31	35	16	37	34	82	3.55	−1.4	20	6,386	se.	36	sw.	11	2	8	21	8.2	4.8	1.2
Tacoma	194	172	201	29.88	30.09	+.05	38.5	−0.3	53	10	43	24	31	33	16	----	----	----	5.06	−1.1	22	6,357	s.	37	n.	31	0	7	24	8.5	13.0	3.5
Tatoosh Island	86	9	53	29.94	30.04	+.06	40.2	−1.0	48	19	43	24	30	38	13	38	36	88	12.04	+0.2	25	13,087	e.	54	e.	31	3	3	25	8.2	7.2	T.
Medford	1,329	29	58	28.74	30.19	----	35.6	----	52	11	41	19	14	30	26	34	32	88	2.03	−0.8	13	3,353	nw.	36	se.	14	2	4	25	8.5	12.4	T.
Portland, Oreg	153	68	106	29.97	30.14	+.06	39.8	+0.4	54	11	44	22	31	35	19	38	35	83	5.63	−1.0	23	4,856	se.	24	sw.	11	3	2	26	8.6	9.8	3.7
Roseburg	510	75	99	29.61	30.18	+.08	39.6	−1.6	58	11	46	22	24	34	28	38	36	84	4.27	−1.0	19	3,228	s.	24	sw.	11	2	7	22	8.4	11.6	1.0
Middle Pacific Coast Region							45.9	−1.4										78	3.04	−1.6										5.6		
Eureka	62	73	89	30.13	30.20	+.10	44.4	−2.5	58	8	50	31	13	39	19	43	40	86	6.84	−0.3	16	5,113	se.	34	nw.	11	7	5	19	6.7	1.6	0.0
Red Bluff	330	5	58	29.79	30.16	+.04	44.8	−1.0	71	7	53	28	24	36	29	40	34	69	1.78	−3.0	7	4,743	n.	24	se.	31	11	6	14	5.7	12.8	0.0
Sacramento	69	106	117	30.08	30.16	+.04	44.0	−1.8	65	10	51	31	14	37	22	42	39	82	1.09	−2.6	10	5,889	se.	38	se.	14	11	11	9	4.5	1.0	0.0
San Francisco	155	208	243	29.99	30.16	+.05	49.3	−0.6	68	10	55	38	14	44	17	45	40	74	3.23	−1.3	14	5,069	nw.	26	se.	14	7	14	10	5.6	0.0	0.0
San Jose	141	12	110	30.02	30.18	----	47.0	−1.3	70	10	56	31	25	38	25	----	----	----	2.28	−0.7	12	4,991	nw.	32	se.	14	9	11	11	5.4	T.	0.0
South Pacific Coast Region							50.1	−1.6										68	2.09	−0.2										4.3		
Fresno	327	89	98	29.82	30.18	+.08	44.8	−1.4	59	11	53	31	14	37	22	42	38	78	1.87	+0.1	8	4,073	nw.	25	nw.	12	8	13	10	5.6	T.	0.0
Los Angeles	338	159	191	29.76	30.12	+.04	53.3	−1.3	75	18	62	34	15	45	26	45	36	56	2.94	−0.2	8	4,734	ne.	27	nw.	28	16	11	4	3.1	2.0	0.0
San Diego	87	62	70	30.02	30.12	+.05	52.2	−2.1	71	11	61	35	24	44	25	47	42	70	1.45	−0.6	8	4,567	nw.	23	w.	13	15	8	8	4.2	0.0	0.0
West Indies																																
San Juan, P. R	82	9	54	29.93	30.02	----	75.1	+0.1	83	3	80	66	9	70	16	----	----	----	6.27	+2.1	24	10,778	e.	37	e.	14	6	23	2	5.1	0.0	0.0
Panama Canal																																
Balboa Heights	118	6	97	----	[1] 29.84	----	79.9	0.0	91	20	88	67	10	72	22	----	----	[1] 79	0.38	−0.4	5	5,542	n.	22	n.	4	3	25	3	6.0	0.0	0.0
Cristobal	36	6	97	----	[1] 29.86	----	81.3	−0.2	87	4	86	71	11	77	14	74	72	[1] 77	1.44	−2.0	17	9,827	n.	26	n.	31	6	13	12	5.8	0.0	0.0
Alaska																																
Fairbanks	455	11	44	[2] 29.44	[2] 30.02	----	−21.0	----	24	31	−11	−54	5	−31	43	−20	−24	78	1.08	----	12	1,595	n.	13	sw.	23	9	6	16	6.4	13.6	33.0
Juneau	80	11	50	[2] 29.72	[2] 29.81	----	27.9	----	43	8	31	10	29	24	14	26	22	79	11.78	----	21	5,673	s.	27	se.	22	8	2	21	7.2	37.3	5.9
Hawaiian Islands																																
Honolulu	38	86	100	[1] 29.97	[1] 30.01	----	73.2	+2.3	81	8	78	65	17	69	14	67	65	78	1.52	−2.3	11	6,809	e.	28	e.	11	8	20	3	4.8	0.0	0.0

[1] Observations taken bihourly.

[2] Pressure not reduced to mean of 24 hours.

TABLE 2.—*Data furnished by the Canadian Meterological Service, January, 1932*

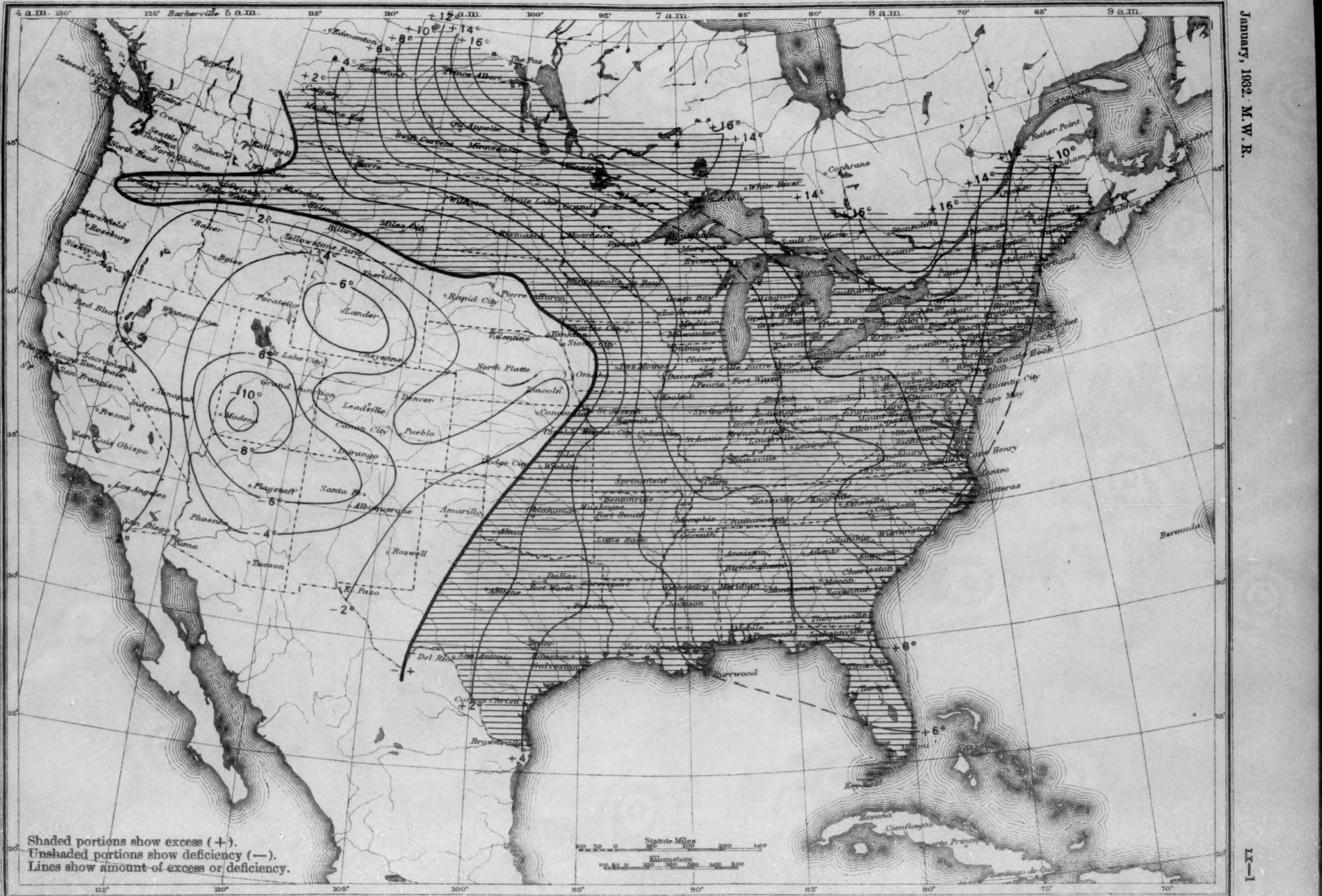
Stations	Altitude above mean sea level, Jan. 1, 1919	Pressure			Temperature of the air						Precipitation		
		Station reduced to mean of 24 hours	Sea level reduced to mean of 24 hours	Departure from normal	Mean max.+mean min.÷2	Departure from normal	Mean maximum	Mean minimum	Highest	Lowest	Total	Departure from normal	Total snowfall
	Feet	*Inches*	*Inches*	*Inches*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	*Inches*	*Inches*	*Inches*
Cape Race, N. F	99												
Sydney, C. B. I	48												
Halifax, N. S	88												
Yarmouth, N. S	65												
Charlottetown, P. E. I	38												
Chatham, N. B	28												
Father Point, Que	20												
Quebec, Que	296	29.73	30.07	+0.05	21.7	+12.6	27.8	15.5	47	−4	4.86	+0.85	24.6
Doucet, Que	1,236				13.2		25.4	1.1	46	−37	3.62		23.1
Montreal, Que	187	29.84	30.06	+.02	26.4	+14.7	32.9	19.9	53	0	4.57	+0.84	14.6
Ottawa, Ont	236	29.80	30.08	+.05	26.9	+17.3	33.8	20.0	54	−4	4.08	+1.09	19.9
Kingston, Ont	285	29.75	30.08	+.03	31.6	+14.5	37.7	25.6	53	4	3.46	+0.01	7.6
Toronto, Ont	379	29.64	30.06	+.01	35.3	+13.9	39.9	30.6	56	13	6.84	+3.92	15.2
Cochrane, Ont	930				12.0		21.0	3.0	43	−31	3.06		25.8
White River, Ont	1,244	28.59	29.96	−.05	12.2	+12.6	21.9	2.5	41	−26	2.28	+0.59	20.8
London, Ont	808				34.3		39.7	28.9	58	5	6.04		6.9
Southampton, Ont	656	29.29	30.02	−.01	32.4	+12.0	37.9	26.9	56	7	3.71	−0.34	12.7
Parry Sound, Ont	688												
Port Arthur, Ont	644	29.26	29.99	−.08	18.9	+15.8	25.8	12.1	42	−16	1.53	+0.71	15.3
Winnipeg, Man	760												
Minnedosa, Man	1,690	28.12	30.04	−.06	4.0	+11.2	14.6	−6.5	35	−39	1.45	+0.65	14.5
Le Pas, Man	860				−1.7		6.7	−10.0	37	−31	0.40		4.0
Qu'Appelle, Sask	2,115	27.63	30.00	−.08	4.5	+8.3	11.9	−2.9	40	−33	0.62	+0.12	6.2
Moose Jaw, Sask	1,759				7.8		18.0	−2.4	43	−32	0.52		5.2
Swift Current, Sask	2,392	27.33	29.99	−.10	10.7	+7.6	20.2	1.1	42	−34	0.88	+0.24	7.8
Medicine Hat, Alb	2,365												
Calgary, Alb	3,540												
Banff, Alb	4,521												
Prince Albert, Sask	1,450	28.41	30.08	−.01	2.2	+10.6	13.2	−8.7	40	−41	0.48	−0.49	4 8
Battleford, Sask	1,592	28.22	30.07	−.01	0.0	+5.9	9.7	−9.7	39	−49	1.62	+1.22	11.8
Edmonton, Alb	2,150												
Kamloops, B. C	1,262												
Victoria, B. C	230	29.81	30.07	+.10	38.0	−0.5	41.3	34.7	50	16	4.29	−1.10	0.6
Barkerville, B. C	4,180												
Estevan Point, B. C	20												
Prince Rupert, B. C	170												
Hamilton, Ber	151												

LATE REPORTS, DECEMBER, 1931

Stations	Altitude	Station pressure	Sea level pressure	Departure from normal	Mean max.+mean min.÷2	Departure from normal	Mean maximum	Mean minimum	Highest	Lowest	Total	Departure from normal	Total snowfall
Father Point, Que	20	29.91	29.94	−.01	21.0	+5.6	27.3	14.8	42	−4	2.68	−0.15	26.6
Winnipeg, Man	760	29.17	30.04	+.02	19.3	+15.2	25.2	13.4	37	−12	0.12	−0.79	0.8
Medicine Hat, Alb	2,365	27.33	29.87	−.10	22.1	+3.9	31.0	13.3	48	−16	2.04	+1.49	17.9
Calgary, Alb	3,540	26.06	29.84	−.10	22.0	+3.8	30.4	13.6	46	−8	1.55	+0.96	15.5
Banff, Alb	4,521	25.16	29.90	−.04	18.8	−0.3	25.6	12.1	40	−8	1.32	+0.11	12.8
Kamloops, B. C	1,262	28.60	29.93	−.01	27.6	−1.3	32.3	23.0	48	−1	1.17	+0.39	11.7
Estevan Point, B. C	20				40.2		45.8	34.7	50	26	13.58		0.0
Prince Rupert, B. C	170				37.6		41.8	33.5	52	24	11.28		0.5

TABLE 2.—Data furnished by the Canadian Meteorological Service, January, 1932

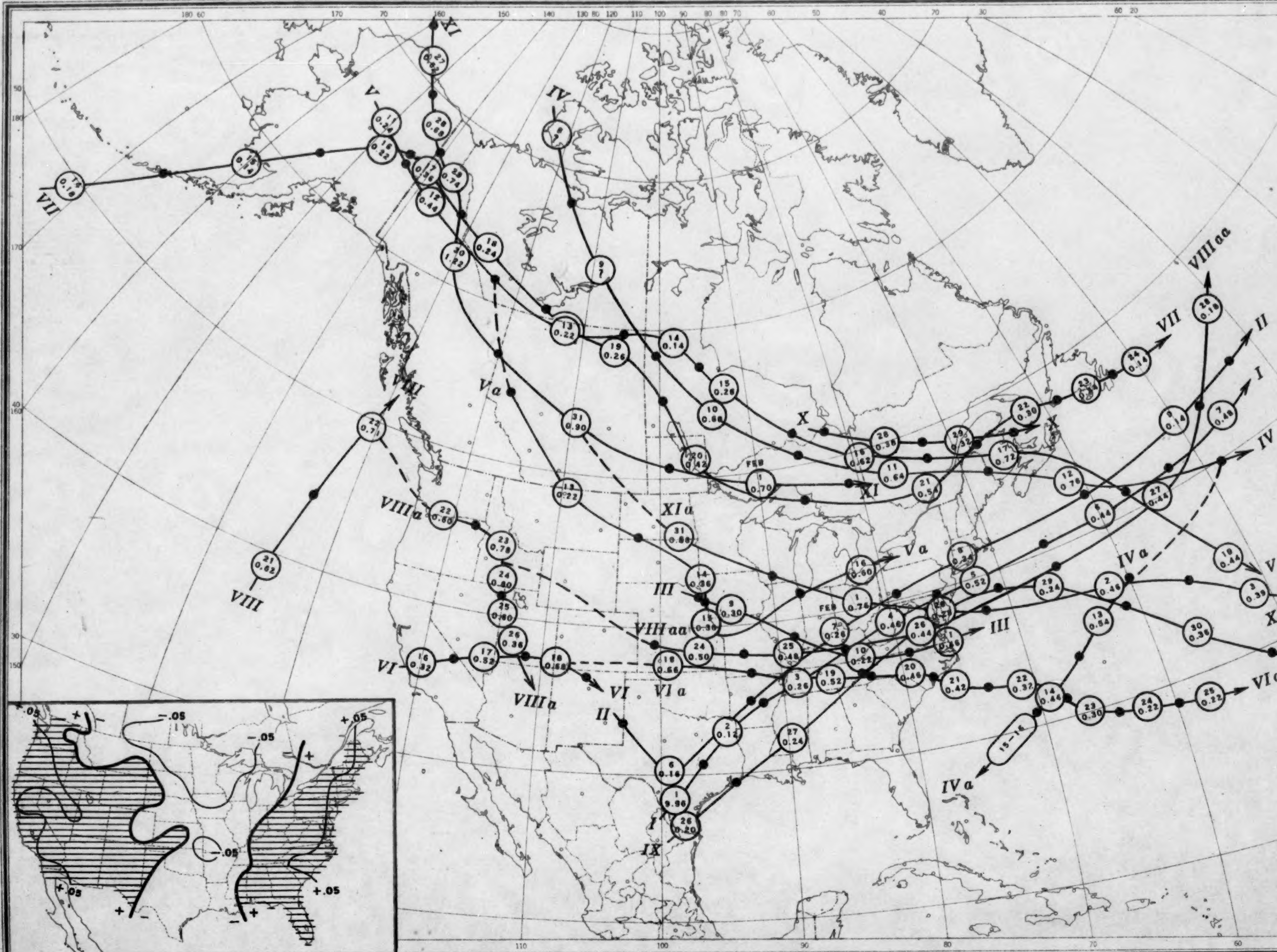
Chart I. Departure (°F.) of the Mean Temperature from the Normal, January, 1932



UNIV. OF MICH.

Chart II. Tracks of Centers of Anticyclones, January, 1932. (Inset) Departure of Monthly Mean Pressure from Normal

(Plotted by G. E. Dunn)



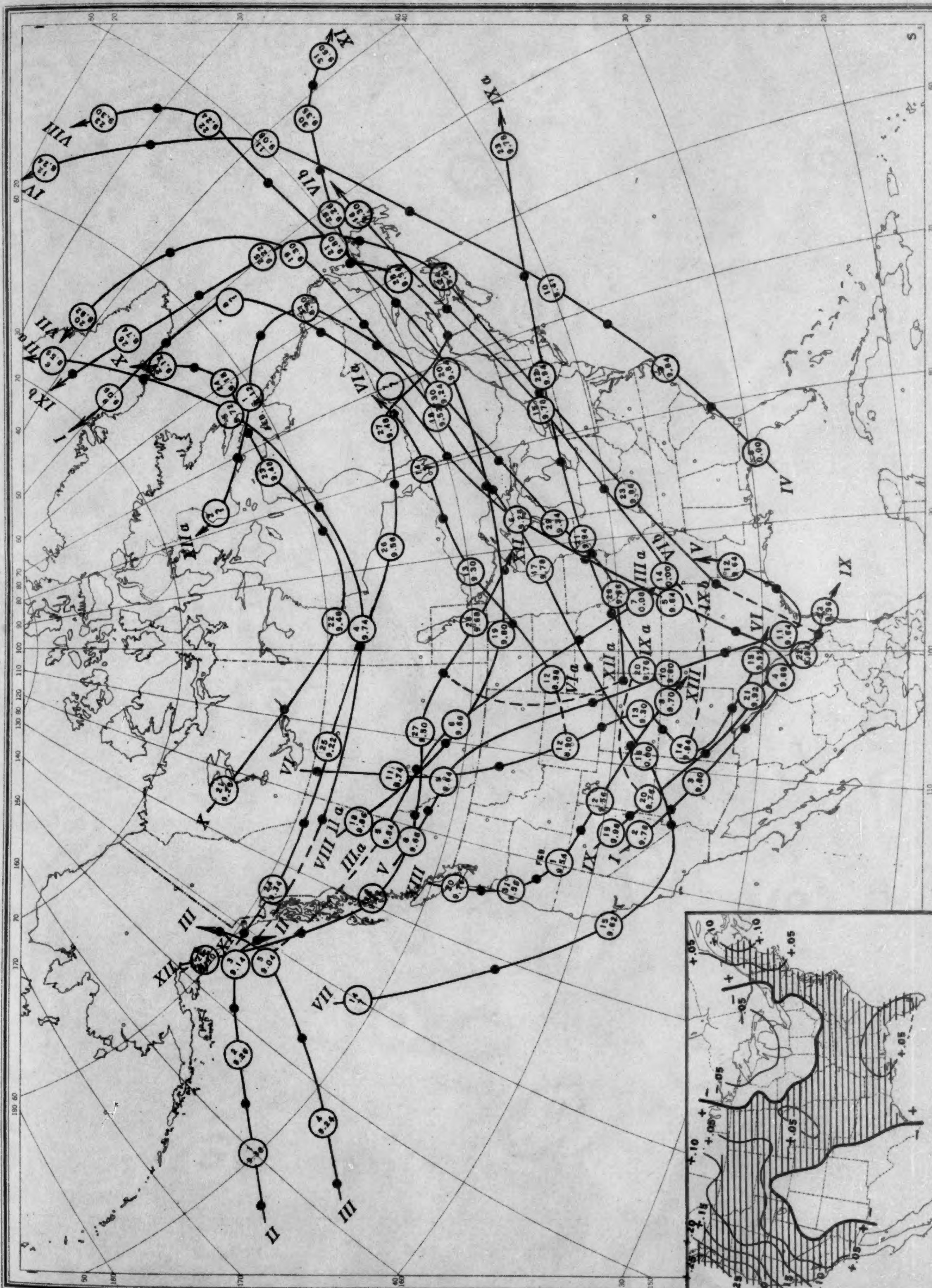
Circle indicates position of anticyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 8 p. m. (75th meridian time).

Chart III. Tracks of Centers of Cyclones, January, 1932. (Inset) Change in Mean Pressure from Preceding Month

Circle indicates position of anticyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 8 p. m. (75th meridian time).

Chart III. Tracks of Centers of Cyclones, January, 1932. (Inset) Change in Mean Pressure from Preceding Month

(Plotted by G. E. Dunn)



Circle indicates position of cyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of cyclone at 8 p. m. (75th meridian time).

UNIV. OF MICH.

Chart IV. Percentage of Clear Sky between Sunrise and Sunset, January, 1932

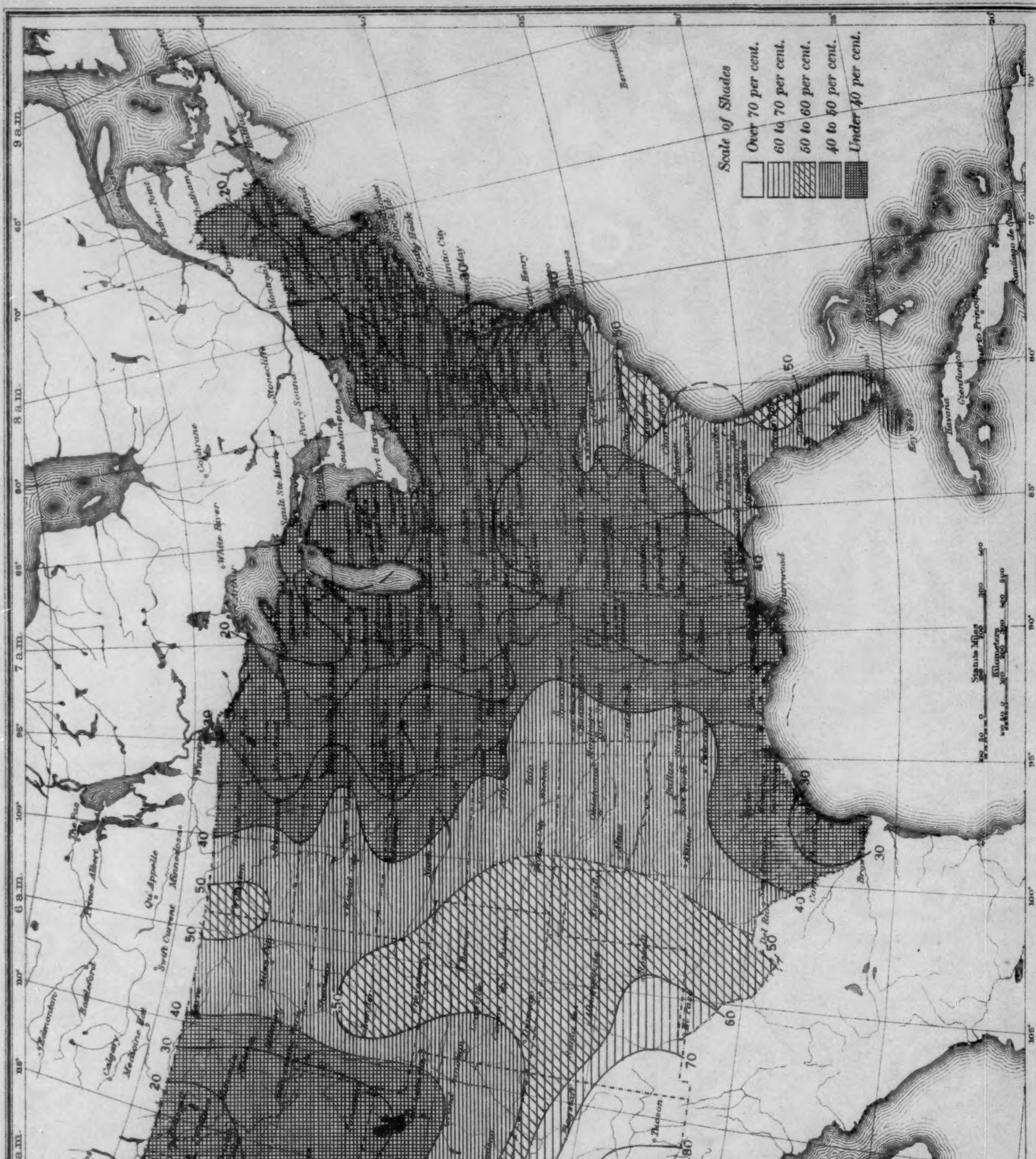


Chart V. Total Precipitation, Inches, January, 1932. (Inset) Departure of Precipitation from Normal

Chart V. Total Precipitation, Inches, January, 1932. (Inset) Departure of Precipitation from Normal

UNIV. OF MICH.

Chart VI. Isobars at Sea level and Isotherms at Surface; Prevailing Winds, January, 1932

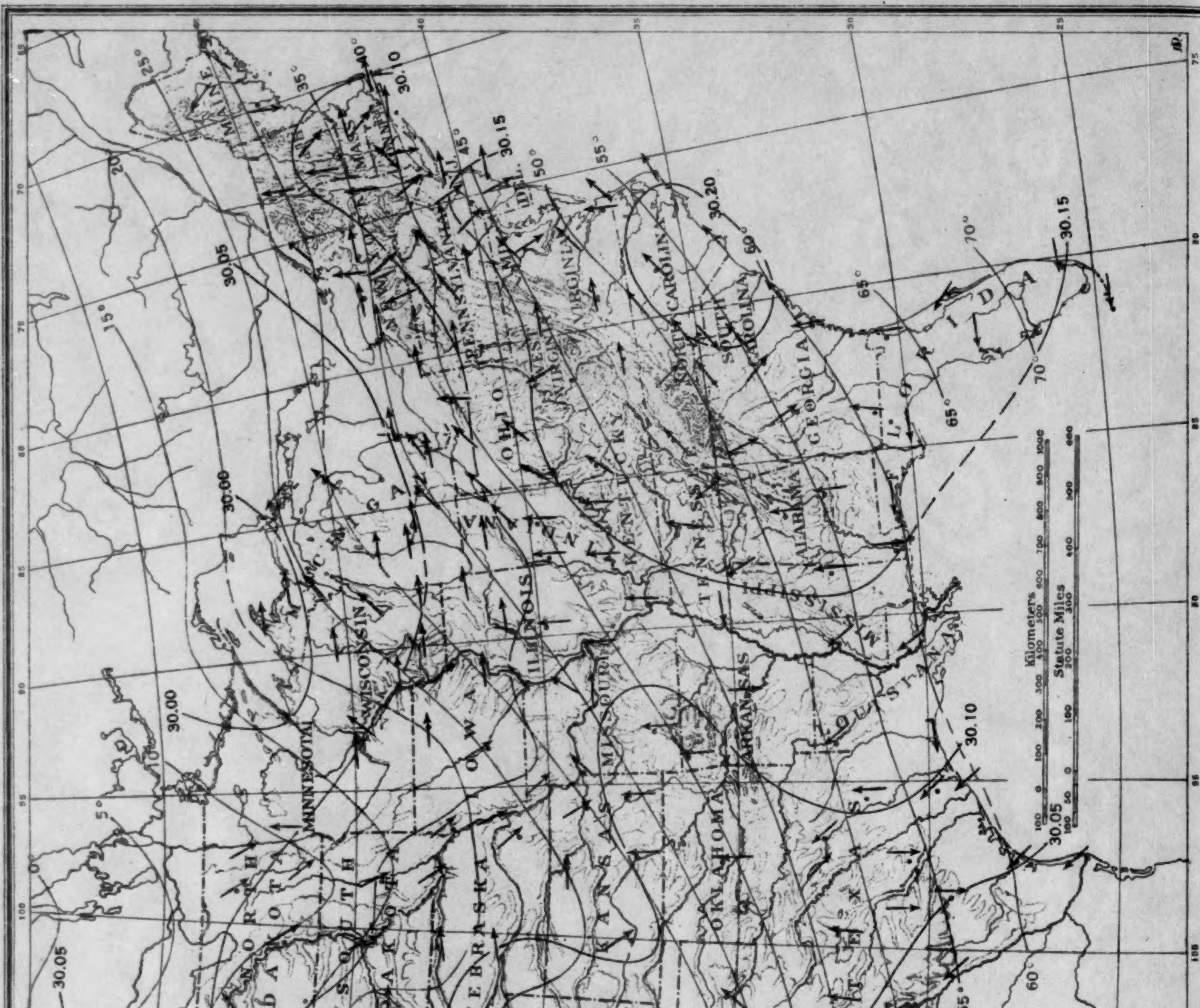


Chart VII. Total Snowfall, Inches, January, 1932. (Inset) Depth of Snow on Ground at end of Month

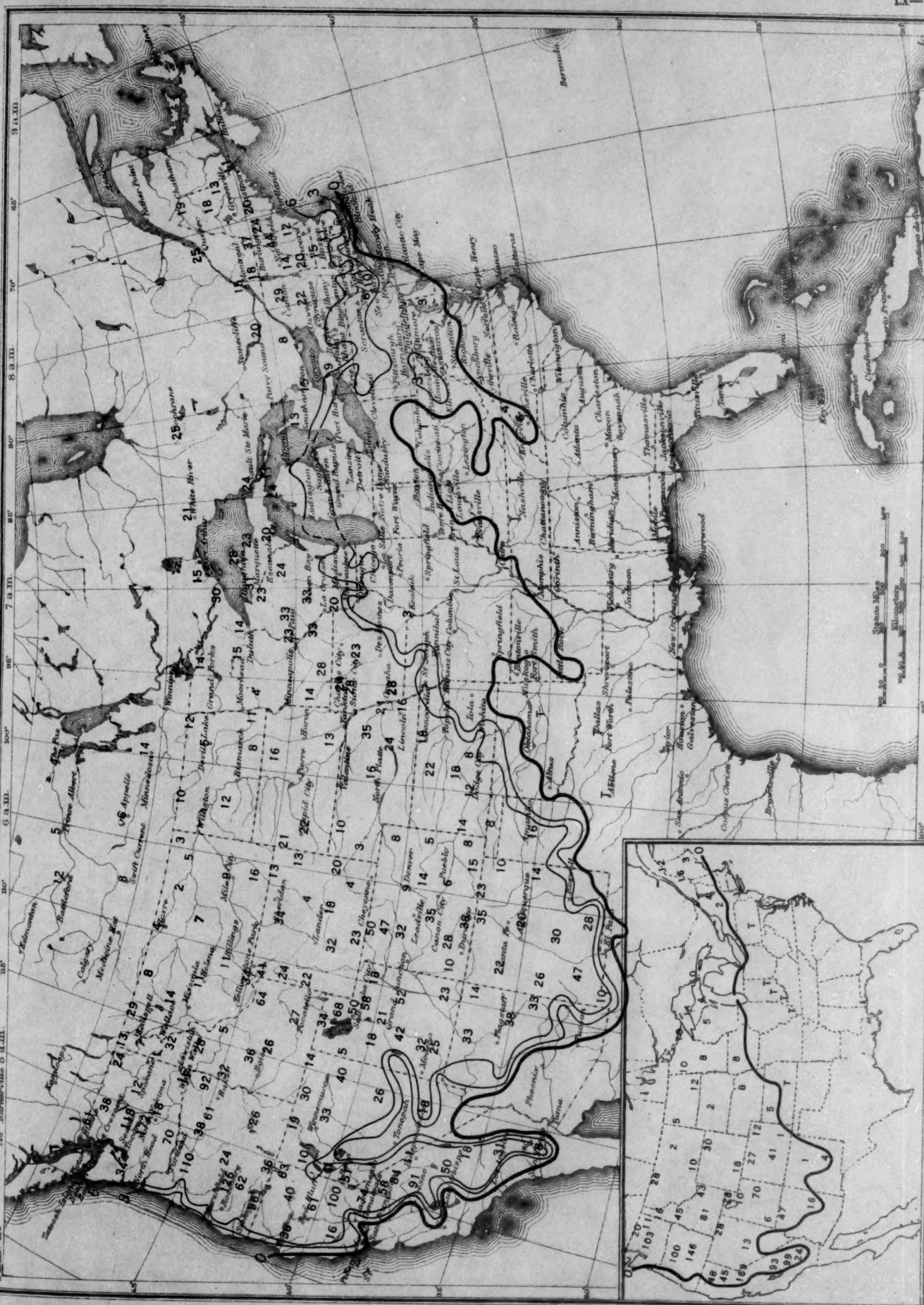


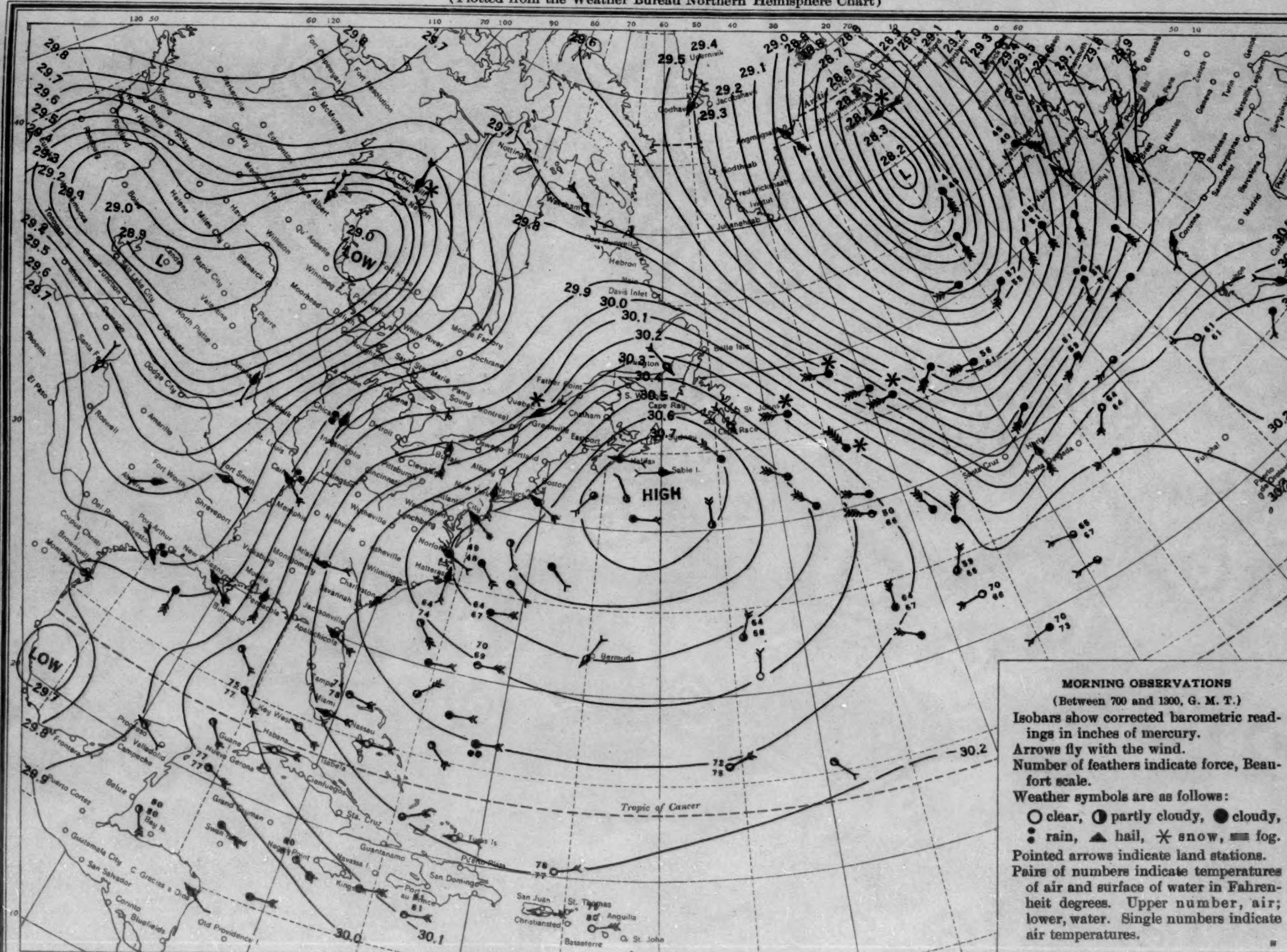
Chart VII. Total Snowfall, Inches, January, 1932. (Inset) Depth of Snow on Ground at end of Month

UNIV. OF MICH.

Chart VIII. Weather Map of North Atlantic Ocean, January 18, 1928

Chart VIII. Weather Map of North Atlantic Ocean, January 12, 1932

(Plotted from the Weather Bureau Northern Hemisphere Chart)



UNIV. OF MICH.

Chart IX. Weather Map of North Atlantic Ocean, January 17, 1932

(Plotted from the Weather Bureau Northern Hemisphere Chart)

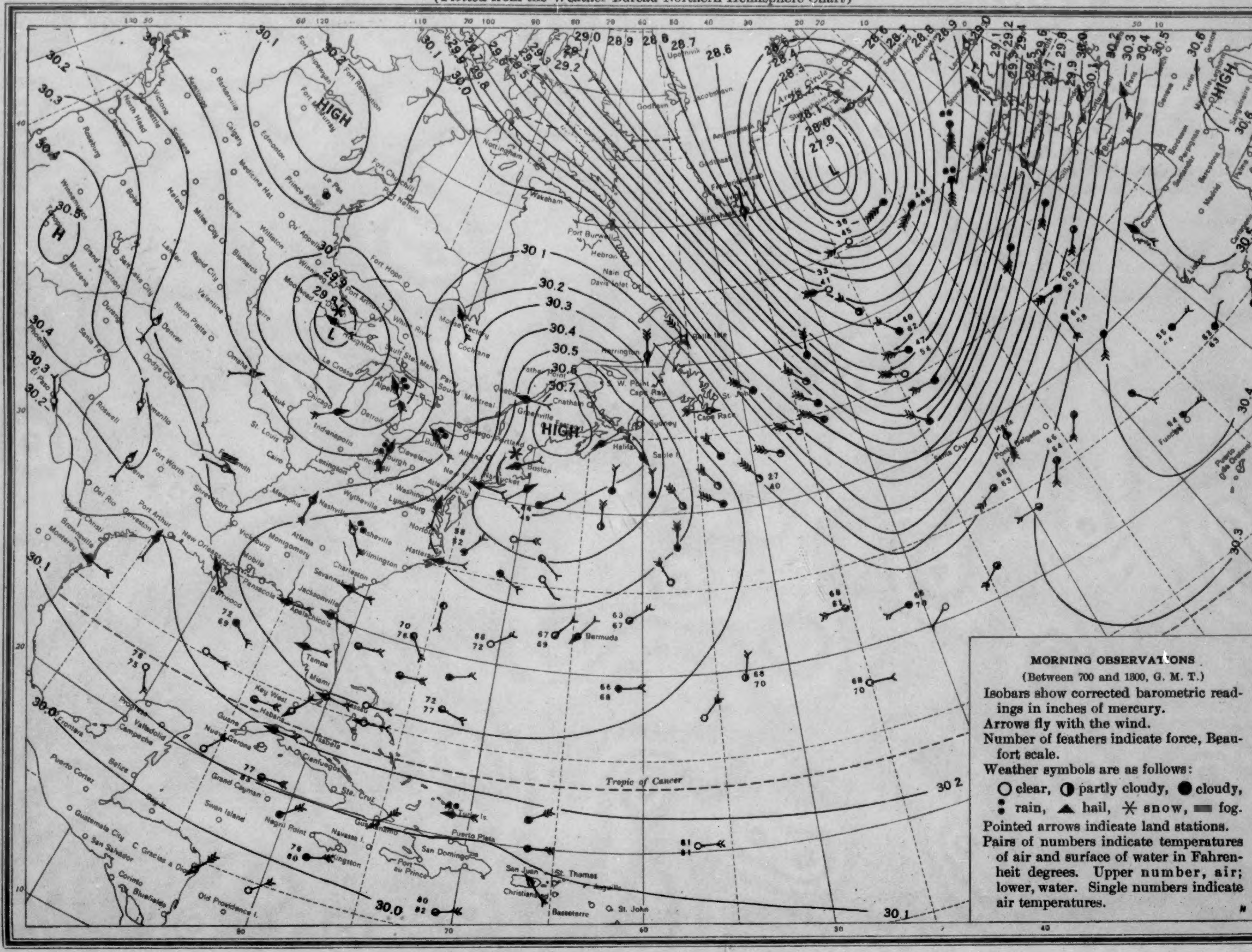


Chart X. Weather Map of North Atlantic Ocean, January 27, 1932
(Plotted from the Weather Bureau Northern Hemisphere Chart)

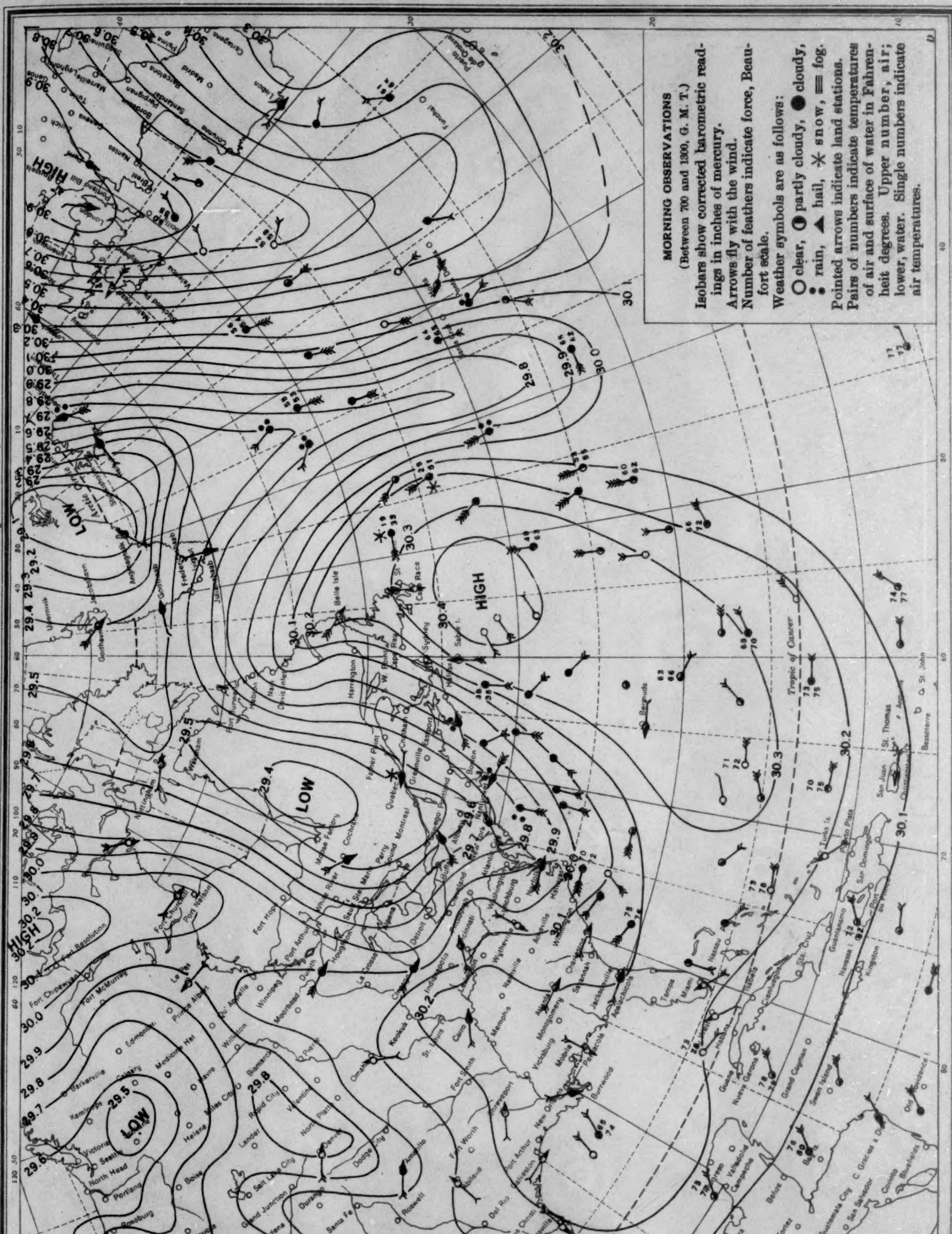


Chart XI. Weather Map of North Atlantic Ocean, January 30, 1932
(Plotted from the Weather Bureau Northern Hemisphere Chart)